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COMPOUND WOUND DYNAMOS.

FOR some considerable time discussions have been going on as to who was the originator of compound winding, and the claims of Paget Higgs, Edison, and Brush have been severally treated upon.

In February of this year the Anglo-American Brush Corporation applied for leave to the Patent Office authorities to file a second disclaimer, which was duly opposed by Messrs. Crompton and Siemens Brothers, although not altogether successfully, and on the 26th August the law officers finally gave judgment in favour of the Company. The ground being thus cleared for action, the Brush Company has lost no time in advertising in most of the papers and sending notices by post to, if we are correctly informed, all manufacturers of dynamos in this country, warning them against infringing their patent, No. 2003, 1878.

Seeing the important issues and possible law suits involved by this action, we publish from the pen of Mr. J. S. Beeman a short account of the subject which we think will be interesting to our readers and tend to show that there may be something said on both sides, and which may therefore relieve their minds from the momentary panic likely to be caused by the action of the Brush Company.

THE ELECTRIC LIGHT IN THE ROYAL NAVY.

(BY A PORTSMOUTH CORRESPONDENT.)

TO feel convinced that the electric light has a great future before it, one has only to look to the great progress which, especially of late, it has made in connection with the Royal Navy. At the present time nearly every large vessel of war is fitted with electric search lights, the value of which cannot be too highly estimated in these days, when torpedo boats and other craft of a like description play such an important part in naval warfare, and which, moreover, are likely so to do to a still greater extent in the near future. Not only, however, is the electric light found to be of eminent utility for warlike purposes, but in many vessels it forms an important feature in the internal economy; in the case, for instance, of the torpedo ram *Polyphemus*, where the whole of the space occupied by officers and men is under water. And as the success of the *Polyphemus*, from a naval point of view, is now regarded as a *fait accompli*, many more vessels will probably be designed on similar plans, and in that case the electric light would be of the greatest benefit for internal lighting purposes, and would have to be very generally used.

The introduction of the electric light into H.M. Dockyards is of comparatively recent date. It was inaugurated in the extensive establishment at Portsmouth some nine or ten years ago, when a foreman and a boy were appointed to pay attention to that branch. Since that time the growing popularity of the electric light has necessitated the employment of about fifty or sixty men, who are under the direction of the electrician (Mr. Lane). A large electric shop has been erected in the extension of Portsmouth Dockyard, where the staff is kept continually employed, and where the necessary apparatus is stored. Every opportunity is afforded by the authorities for the testing of any new electric lighting machinery, and trials of engines, dynamos, &c., are of frequent occurrence in the electric shops, reports thereon being afterwards forwarded to the Admiralty. So rapidly has the work devolving on this department grown, that employment could be found for a much greater number of men than those at present engaged; and this in spite of the fact that the work of supplying and fitting the electric light on board large vessels is generally undertaken by large private firms. The vessels now being fitted with the electric light at Portsmouth and Chatham include the turret ships *Devastation*, *Edinburgh*, and the barbette ships *Warspite*, *Imperieuse*, *Collingwood*, and *Rodney*. The work on the *Devastation* at Portsmouth has been entrusted to the firm of Messrs. Goolden and Trotter, they having fitted out, amongst other vessels, the *Polyphemus*, as well as numerous ships belonging to the Peninsular, Oriental, Allan, Guion, and other lines. The eminent firm of Messrs. Siemens Brothers & Co. has secured the contract for the carrying out of the work on board the other vessels mentioned. Besides search lights, the *Devastation* will be supplied with a large number of incandescent lamps for the cabins and decks; the electrical current being obtained from a dynamo and high-speed driving engine of special types. With regard to the other vessels, the *Collingwood* and *Imperieuse* are now being dealt with at Portsmouth, and as the other ships will be treated in a similar way, it may be well to take the case of one as typical of the others. Every part of the *Collingwood*, for instance, is to be fitted with incandescent lamps which are guaranteed to work in perfect order for an average period of 1,000 hours. Altogether, over 400 incandescent lamps will be brought into requisition, each being of 20 candle-power, and the two search lights, which will be placed one in the fore and the other in the after part of the ship, are to be of 25,000 candle-power. It is stated that the projectors, which have been manufactured by Messrs. Siemens Brothers & Co., will enable anyone with the naked eye to see an object clearly at a distance of seven miles from the ship; but for the present the vessels in question will be supplied with those which have been manufactured in the Dockyard. The electric current will be circulated by means of three dynamos of the self-regulating pattern, capable of lighting each 250 lamps of 20 candle-power; the electromotive force being 80 volts. Two of these machines will be used at the same time, and the third will be kept in reserve to provide for any accident that may occur; whilst the same provision is to be made in respect of the fittings generally. The dynamos will be worked by two high-speed engines. The dynamo room will be situate in the fore part of the vessel, on the lower or platform deck, and the arrangements for lighting will be carried out in five circuits. The carrying of the wires from place to place calls into play the exercise of no common ingenuity, as it is frequently necessary to pierce iron plates of, say, six inches in thickness, before progress can be made; while in the case of a water-tight bulkhead, the hole which is pierced has to be plugged with a "gland" of impervious material, through which the wire is passed. In the case of the large armour tower, the wires have to be carried below decks and brought up inside the protecting cylinder. Some difficulty has been experienced in the case of revolving turrets, it having been found that the wires interfered with the movements of the turret; but this drawback has now been obviated. The wires are so laid that metallic contact is impossible, and as they are all out of reach, no danger could possibly result through the curiosity of anyone to see what is the effect of an electric shock.

Improved switching arrangements are to be provided, by which either of the dynamos can be brought into communication with any part of the ship by a special switch-board. The whole of the lamps can be simultaneously switched off from the dynamo room, or from that part of the vessel which they illuminate. The magazines, in which, of course, no lights must be taken, are illuminated by means of reflectors, and where necessary, other parts of the ship are lighted in a similar manner. At the yard-arm on either side of the vessel, amidships, a ring of light produced by a circle of 15 lamps will be formed. From these particulars it will be seen that the arrangements will be of the most complete character, and on a scale which has seldom been equalled.

COMPOUND WINDING OF DYNAMOS.

By J. S. BEEMAN, M.S.T.E.

PUBLIC attention having been prominently brought to bear upon this subject through the course pursued by the Anglo-American Brush Electric Light Corporation, as the owners of Patent No. 2,003 of 1878—or rather of such portions as they have not disclaimed—which patent was granted to H. J. Haddan on behalf of C. F. Brush, of Cleveland, Ohio, it seems a favourable opportunity for investigating the alleged exclusive rights of the Anglo-American Brush Corporation to manufacture compound wound machines.

Before doing so it will be well to quote certain passages of this patent, and the claim based upon Division 4, which are as follows :—

Division 4 of my invention has for its object the maintenance in dynamo-electric machines of a "magnetic field" while the machine is running, whether the external circuit is closed or open in dynamo-electric machines as ordinarily constructed. In dynamo-electric machines, as ordinarily constructed, no magnetic field is maintained when the external circuit is opened, except that due to residual magnetism, hence the electromotive force developed by the machine in this condition is very feeble. It is only when the external circuit is closed through a resistance not too large that powerful currents are developed, owing to the strong magnetic field produced by the circulation of the currents themselves around the field magnets. Such machines are not well adapted to certain kinds of work, notably that of electro-plating. For this purpose a machine arranged to do a large quantity of work at one operation may fail entirely to do a small quantity, because of the comparatively high external resistance involved in the latter case, and the low electromotive force of the machine at the start. Again, it is well known that during the process of electro-plating a very considerable electromotive force is developed in the plating bath in a direction opposed to the current from the dynamo-electric machine. If now the current is momentarily weakened by accident or otherwise, its magnetic field, and consequently its electromotive force, are correspondingly reduced. If the latter falls below the electromotive force of the bath, it will be overcome by it, and the machine will have the direction of its current reversed. This accident often happens with plating machines, and is a source of much annoyance. It will now be obvious that if even a moderately strong magnetic field be constantly maintained within the machine, both of the above described difficulties will be eliminated. Other useful applications of a "permanent field" machine will readily suggest themselves. I attain my object by diverting from external work a portion of the current of the machine, and using it either alone or in connection with the rest of the current for working the field magnets. I prefer the latter plan of the two just above mentioned, especially for electro plating machines. If now the external circuit be broken entirely the magnetic field will in the former plan just mentioned remain unimpaired, and in the latter plan will remain sufficiently strong to effect the desired end. In applying my invention to dynamo-electric machines, I wind the cores of the field magnets with a suitable quantity of a comparatively fine wire, having a high resistance in comparison with that of the external circuit and the rest of the wire in the machine. The ends of this wire are so connected with other parts of the machine that when the latter is running a current of electricity constantly circulates in said wire whether the external circuit be closed or not. The high resistance of this wire prevents the passage through it of more than a small proportion of the whole current capable of being evolved by the machine; therefore the available external current is not materially lessened. When this device, which I have called a "teaser," is used in connection with field magnets, also wound with coarse wire (as shown in Figure 1 of the drawings) for the purpose of still further increasing the magnetic field by employing the main current for this purpose in the usual manner, then the "teaser" may be so arranged that the current which passes through it will also circulate in the coarse wire, thus increasing the efficiency of the device.

. . . . . .

Claim 7 founded upon above Division 4 reads as follows :—

"In a dynamo-electric machine the wire or helix E, having a comparatively high resistance, and kept in closed circuit while the machine is running, in combination with the magnetic wire or helix F as commonly employed, substantially as shown in Division 4."

The reader should bear in mind that a claim lately struck out from the patent covered pure shunt machines, and no object to be attained is described in Division 4 of the specification, which a pure shunt machine will not accomplish, while a pure shunt machine in many cases is not nearly so likely to have the direction of its current reversed during electro-plating or charging of accumulators as a compound-wound machine.

Leaving out of the question whether or not manufacturers making constant electromotive force machines or modern compound-wound dynamos, for other purposes than electro-plating, interfere with the Brush patent, I think the following extract from a patent taken out in this country some time previous to the date of the Brush patent 2,003 of 1878, bears on the subject :—

"Part of the electricity developed by the machine is diverted to maintain the magnetism of the soft iron magnets and the remaining portion is used to produce the electric light. There are several well-known ways of doing this, but the method I prefer is to wrap the soft iron magnets with two insulated wires, one having a larger resistance than the other. The circuit of larger resistance is always closed, and the circuit of less resistance is used for the electric light.

"When the electric light is being produced the greater portion of electricity passes through the circuit of less resistance which I term the '*electric light circuit*,' maintaining the magnetism of the magnets and producing the light. When the electric light circuit is opened from any cause the electricity developed passes through the circuit of greater resistance only and maintains the magnetism of the magnets."

This extract clearly shows that the species of compound winding, as claimed by Brush, had been anticipated, and this in my opinion renders the Brush patent useless and invalid.

A NEW DEPREZ-D'ARSONVAL GALVANOMETER.

THIS new galvanometer shown in elevation in figure 1, and which is described in a recent number of *La Lumière Electrique*, has important practical advantages.

It is distinguished from former models by the suspension of the coil which, instead of being vertical is horizontal, so that the index needle moves in a vertical plane.

There are two types of these galvanometers. The first with a coil of great resistance, about 2,300 ohms, is intended to be used as a voltmeter ; the second with a coil of low resistance, 1·4 ohm with the connections, is destined to serve as a shunted ampèremeter.

In both cases the coils are suspended by steel wires of 0·2 millimetres diameter and 10 centimetres in length.

The sensitiveness in the first case is about 18° for 1 volt, and in the second 12° for 0·01 ampère.

The steel wire is fixed on one hand to a spring, which is seen in fig. 1 behind the galvanometer, and on the other to a button represented on the front of the little board ; this allows the wire to be turned, thus causing the needle to take any position of equilibrium on the coil, which is often very useful. Thus for measuring currents the direction of which may vary, the needle is set vertically, that is to say, at 50°. When the currents are in the same direction the needle is

placed at 0° or 100°, according to the direction of the current, so as to have a more extended scale.

Fig. 2 shows the section of this button; the wire is compressed between the halves of a double steel cone, *n*. This cone is fixed in a tube which may be moved in the direction of the axle by turning the screw, *b*. By turning the button, *c*, we give to the whole a

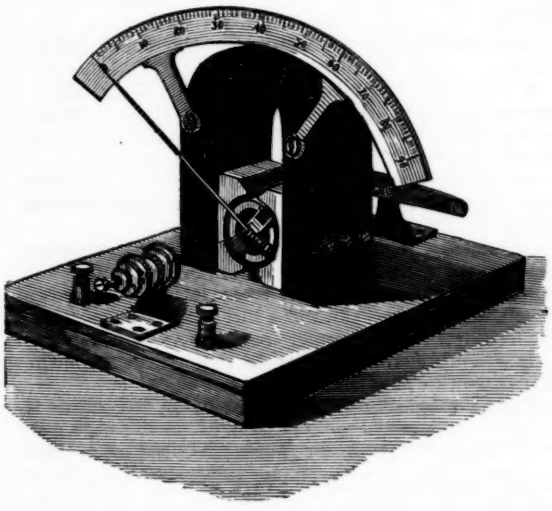


FIG. 1.

rotatory movement which displaces the needle on the coil. The button, *c*, itself bears upon a plate fixed by three screws, *l*, on the support of the button; the

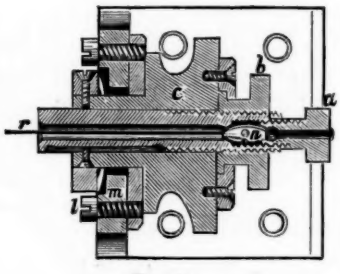


FIG. 2.

screws permit the movement of the button and, consequently, of the axis of suspension to a small extent in all directions.

The pole pieces (fig. 3) added to the magnets by Marcel Deprez render the galvanometer proportional from 0° to 100°, and as the coil has a radius of about

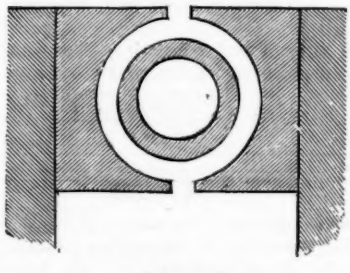


FIG. 3.

20 centimetres, the scale traversed by the needle is about 100 millimetres in length, which enables us to measure with considerable precision currents whose relative strengths may vary as much as 1 : 10.

A point which must be carefully attended to in regulating the apparatus is, that the centre of gravity of the coil and the needle must be exactly on the axis of suspension. Without this, notwithstanding the homogeneity of the magnetic field, the deviations will not be proportional to the currents.

The following is the most practical means of effecting this regulation :—

Suppose that the centre of gravity is not on the axis of suspension, but *e.g.* at A (fig. 4). We can then

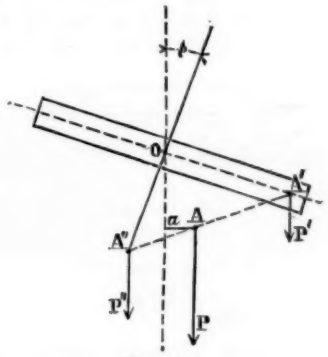


FIG. 4.

decompose the weight, P, of the coil into two components, P′ and P″, acting, the one at a point, A′, of the axis of symmetry of the apparatus, the other, P″, at a point, A″. situate on a perpendicular to the axis of symmetry, passing through the point of suspension, O.

The moment of torsion produced by the excentric position of the centre of gravity for any position whatever of the coil is then equal to

$$P\,a = P'\,O\,A'\cos.\,\phi - P''\,O\,A''\sin.\,\phi$$

which corresponds to an angular deviation of

$$\Delta\,\phi = \frac{P'\,O\,A'\cos.\,\phi - P''\,O\,A''\sin.\,\phi.}{q.}$$

where q is the directive movement opposed to the movement of rotation and derived in our case from the torsion of the wire; q is the moment for a rotation $\phi = 1$.

The two moments, M and M′ M = P′ O A′ cos. ϕ, M′ = P″ O A″ sin. ϕ may be brought to O, M′ by screwing more or less a counterpoise on the stem, O A″ (which has a screw thread) and M, by adding a weight on one of the two sides of the coil.

It is required to separate the action of M and M′; for this purpose we bring back the needle to its vertical position by turning the button to which the suspending wire is attached. At this point M′ = O and M has its maximum value.

We reverse the galvanometer so as to place the suspension wire in a vertical position, which it is easy to do by placing a support under the magnet.

In this position M and M′ are both nil, and the needle deviates by an angle $\Delta\,\phi$. We have

$$q\,\Delta\,\phi = M'.$$

We replace the galvanometer in its normal position, and we fix on the coil an excentric weight, P″, such that the needle takes the position which it had when the wire was vertical.

By this M will be almost completely annulled, and we only need repeat the operation once more to approach more closely to the equilibrium.

M′ produces its maximum effect in the most inclined position of the needle, that is at 0° and at 100°. This moment is equilibriated in the same manner by reversing the galvanometer and screwing the counterpoise up or down.

When the coil is well equilibriated experiment shows that the deflections are really proportional to the currents, the difference not amounting to 1 per cent.

Among the constants of the apparatus which it is

interesting to know are :—1. The intensity, h, of the magnetic field in which the coil moves; and 2, the directive movement, q, due to the torsion of the wire for an angle equal to 1.

I assume as known the dimensions of the coil, which otherwise can be easily measured; the resistance, R, and the diameter of the wire employed. From this last datum we deduct the resistance, r, of the wire per metre run; its length will then be $\frac{R}{r}$. $= L = 2\,n\,(a + b)$, n being the number of revolutions, a the mean length of the side of the coil moving in the magnetic field, and b the length of the other side (fig. 5).

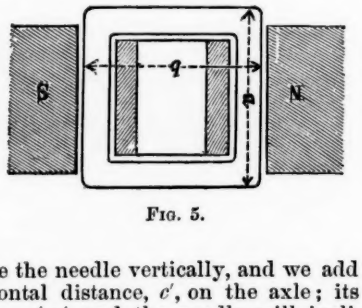


FIG. 5.

We place the needle vertically, and we add a weight at a horizontal distance, c', on the axle; its moment will be $m = c'\,p'$, and the needle will incline to the side of the weight. We can make it return to its original position by passing through the coil a current, i, which we measure by any method. In this manner we eliminate the action of the directing couple, q.

The equation expressing the equilibrium is then

$$m = c'\,p' = n\,a\,b\,h\,i$$

whence

$$h = \frac{m}{n\,a\,b\,i}$$

In several instruments we have found for h values about 600 units (C.G.S.). We now remove the weight, p', the needle deviates by an angle ϕ, the electric couple remains the same, $= m$; the directing couple being $q\,\phi$ we have

$$q = \frac{m}{\varphi}.$$

Knowing q, it will be easy to calculate the moment of inertia, I, of the coil from the duration, T, of an oscillation. We have in fact:

$$I = \frac{T^2}{4\,\pi^2}\,q.$$

This value, however, is more useful to be known for a galvanometer with a vertical suspension and with a mirror for reading off. Such being more sensitive are more fit to be employed as ballistic galvanometers. The damping resulting from the induced currents which render the galvanometer aperiodic is always nil during a ballistic deviation, the circuit not being closed.

By making use of the discharge of a condenser of known capacity, C, charged to a known potential, V, we can obtain a relation between the constants of the apparatus which may be of some service:

$$C\,V = \frac{\phi\,0\,\sqrt{I\,q}}{n\,a\,b\,h}$$

where $\phi\,0$ is the maximum deviation.

One of the advantages of the concentric pole pieces is to produce a constant field with the lines of axial forces, so that the sensitiveness of the instrument is not affected by impurities in the copper employed, and with the result of rendering it slightly magnetic; in fact, the magnetic forces which may arise are directed radially and have no tendency to turn the coil either in one direction or another.

The sensitiveness of these high resistance galvanometers or voltmeters may be easily modified by means of some additional resistances, as shown in fig. 6.

To find the difference of potential between two points we apply at these points the extremities a and b of the wire; we place a resistance of *e.g.* 5,000 ohms in series with the voltmeter and we calculate the shunt, S, so that the voltmeter gives the wished-for number of divisions per 1 volt. We may modify the sensitiveness by fixing upon a small board several shunts, S, giving different sensibilities; the shunts also render the voltmeter aperiodic.

Ampèremeters.—In ampèremeters the movable coil forms a derivation from the main current which is traversed by a conductor of low resistance, *e.g.*, a thick copper wire fixed in zig-zag under the board between a and b.

It is evident that by modifying the dimensions of this conductor we may render the ampèremeters more or less sensitive; the resistance may always be neglected as it varies between $\frac{1}{200}$ and $\frac{1}{1000}$ ohm.

As the thick wire must always remain in the circuit, it must have sufficient dimensions so that no error may arise from the heating of this wire.

Let us take, for example, for this conductor a copper wire of 0·4 centimetres in diameter. Let us put as limit of the error derived from heating, 2 per cent., which would correspond to a heating of the wire of 5°, the coefficient for copper being 0·38 per cent. per degree, and examine what is the maximum current which we can pass into it.

The heat developed by a current in a conductor is per second $\frac{R\,i^2}{J}$ in absolute measurement, i being the mechanical equivalent of the heat; the heat lost by radiation is $\pi\,d\,l\,h\,\Delta\,t$; d being the diameter of the wire, l the length, and h the heat lost per second and per unit of surface of the conductor for a difference of temperature of 1°. The maximum elevation of tempe-

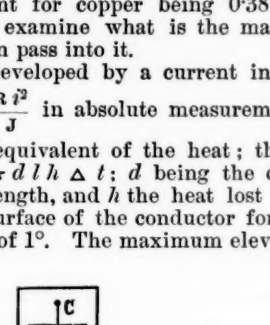


FIG. 6.

rature $\Delta\,t$ of the conductor will then be

$$\pi\,d\,l\,h\,\Delta\,t = \frac{R\,i^2}{J}$$

and

$$R = \frac{4\,\rho\,i^2\,l}{\pi\,d^2}$$

whence

$$\Delta\,t = \frac{4\,\rho\,i^2}{\pi^2\,d^3\,h\,J}$$

ρ = the specific resistance of copper = 1,700 units (C. G. S.). J = the mechanical equivalent of heat = 42×10^7; h for copper bare and exposed to the free air = 2×10^{-4}

We have then for i, admitting 5° as the maximum heating of the wire by the current:

$$i = \sqrt{\frac{\pi^2\,d^3\,h\,J\,\Delta\,t}{4\,\rho}}$$

$$= \sqrt{\frac{10 \times 64 \times 10^{-3} \times 2 \times 10^{-4} \times 42 \times 10^7 \times 5}{4 \times 1700}}$$

$= 1{\cdot}98$, that is in absolute measurement 19·8 ampères.

We cannot then permit more than 20 ampères to pass into the ampèremeter shunted in this manner; consequently the length, L, of the conductor must be determined in such a manner that the needle may traverse the whole coil for about 20 ampères, *i.e.*, we must have about 5° of deflection per ampère.

If we wish to measure stronger currents we must select a thicker main conductor or keep it artificially at a constant temperature.

It is true, on the other hand, that the derivation of the current passing through the coil heats it considerably and compensates in part for the error derived from the heating of the thick conductor.

The maximum current passing through the coil is that which makes it deviate by 100°. This current is the same for all galvanometers of the same make, and it is equal to about $\frac{1}{12}$ ampere.

The only part liable to become heated is the steel wire of 0·2 mm. in diameter supporting the coil, the diameter of the copper wire of the coil being 0·6 mm.

The heating of the steel wire will be:

$$\Delta t = \frac{4\rho i^2}{\pi^2 d^3 h J} = \frac{4 \times 9825}{10 \times 8 \times 10^{-6} \times 2 \times 10^{-4} \times 4{\cdot}2 \times 10^7} \times \frac{1}{14400} = 4 \text{ . °I.}$$

which produces a change of resistance of 1·56 per cent. The length of the steel wires being 20 centimetres their resistance is 0·63 ohm; that is to say the $\frac{0{\cdot}63}{1{\cdot}4}$ part of the resistance of the coil and of its communications; the augmentation of the resistance of the coil will therefore be $\frac{63}{140}$ 1·56 = 0·7 per cent. Hence the total error will not be greater than 2 per cent. — 0·7 per cent. = 1·3 per cent.

To have 5° per ampère the resistance of the thick conductor must be $\frac{1}{170}$ ohm, which gives it a length of more than 4 metres, which is a very inconvenient length. The more the current to be measured increases the more necessity there is for taking a thick wire. Hence it is preferable to use nickel silver instead of copper; the length can be about 13 times smaller since the resistance is 13 times greater; the heating will also be 13 times greater, but the increase of the resistance of nickel silver for 1° is $\frac{44}{380} = 0{\cdot}116$ of that of copper, so that it is only needful to increase slightly the dimensions of the nickel silver to remain in the same conditions of exactitude.

We have a further means of rendering this conductor more manageable, that is by substituting for the thick wire several finer ones. The formula shows us that if we substitute for one thick wire, n, smaller ones of the same total section and the same length and consequently of the same resistance, we obtain the heating $\Delta t'$

$$\Delta t' = \frac{4\rho\left(\frac{i}{n}\right)^2}{\pi^2\left(\frac{d^2}{n}\right)^{\frac{3}{2}} h J} = \frac{1}{n^{\frac{1}{2}}} \frac{4\rho i^2}{\pi^2 d^3 h J}$$

$$\Delta t' = \frac{\Delta t}{\sqrt{n}}$$

Hence we may make the dimensions of the conductors $\sqrt{n}$ times smaller; they may be enclosed in a box of moderate size attached to the galvanometer.

It would also be advisable to cover these wires either with lamp black or caoutchouc to facilitate the radiation.

The ampèremeter being shunted with a resistance very small in comparison with that of the coil is absolutely aperiodic; it may be employed to follow even very rapid variations of the current, produced *e.g.* by irregularity in the movements of the motor.

ELECTRIC LIGHT SWITCHES.

WE illustrate below two forms of switches lately designed by Mr. N. G. Thompson, of Messrs. Thompson, Dowsing and Rew. The large switch (Figs. 1 and 2) has been constructed with a view to balancing the pressure generally found necessary to form good contact, and to compensate for wear and tear. In the majority of switches now made for heavy currents the requisite pressure is given by means of a spring acting on the spindle, which throws the wear and strain on that part. This is obviated in Mr. Thompson's switch by making the contact plates in the form of a cylinder

FIG. 1.

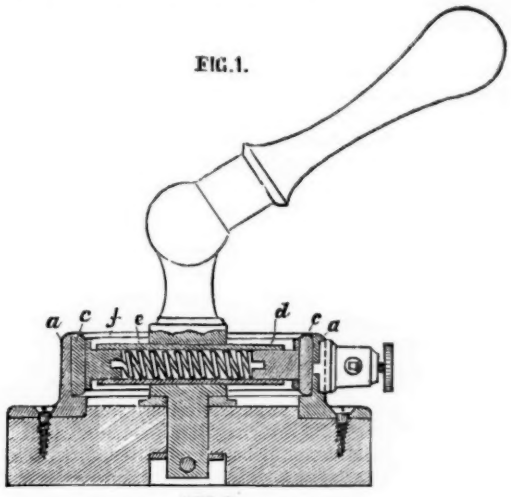
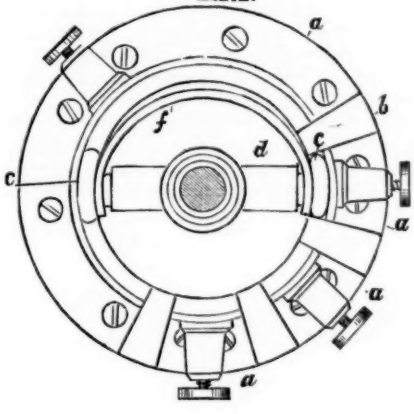


FIG. 2.



cut into segments, *a*, *a*, *a*, and secured by a flange to the wood base, *b*. Two plugs, *c*, *c*, are fitted loosely into the cross tube, *d*, and are forced out against the segments by means of the spiral spring, *e*. A strip of metal in the form of a bow, *f*, is also secured to the

FIG. 3.

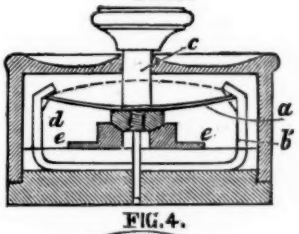
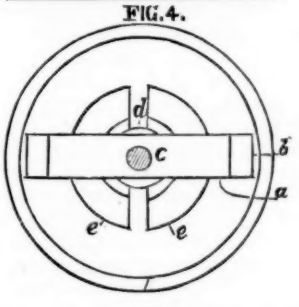


FIG. 4.



plugs, *c*, *c*, and any convenient handle is attached to the tube, *d*. It will be seen from this that the pressure on the segments is completely balanced, without in any way affecting the spindle and handle to which the tube is fixed. The bow-shaped piece of metal, *f*, conveys

the current from one plug to the other, and at the same time aids the action of the spiral spring. The result of this balanced action is to make the switch remarkably free to move, and at the same time permits of the desired pressure.

Figs. 3 and 4 show a smaller form of switch, or, more properly speaking, contact breaker, suitable for one or more incandescent lamps. Its construction is exceedingly simple, and its action most positive. *a* is a short length of riband steel, maintained in a bow form by a stiff piece of metal of channel shape, shown at *b*. A spindle, *c*, carrying the handle, passes through the spring, *a*, and is secured to a cylindrical plug, *d*, in such a way that the spring and plug move with the spindle, while at the same time the spindle and plug are permitted a revolving action free of the spring. The plug, in the position shown, presses against two halves of a metal cylindrical base, *e*, to which the wires are attached respectively. The action will be as follows :—If the handle is pulled out from the switch, the plug and spring will pass into the new position shown by dotted lines, and thus break the circuit, and the spring, in passing through its intermediate positions, will force out the ends of the metal base or holder, *b*, which acts as a powerful secondary spring, maintaining the spring, *a*, in either of the two positions indicated. It is impossible to fix the plug and spring in any other or intermediate position, and the action of making or breaking contact is exceedingly sure and sharp. The revolving play of the plug and handle gives facilities for grinding and cleaning the contacts.

We understand that Mr. Thompson has entered applications at the Patent Office for each of these designs.

SIXPENNY TELEGRAMS.

IN view of the excess of work in telegraphing, on and after the 1st of October next, the Postal Telegraph authorities have made enormous extensions and improvements, both at the London Central Telegraph Offices and the other offices throughout the provinces. To meet the extra demand anticipated upon the adoption of the sixpenny rate three new trunk lines of wire have been erected ; the first from London, *viâ* Peterborough, Doncaster, York, and Darlington, to Newcastle ; the second from London, *viâ* Aylesbury, Widnes, Leamington, then north of Birmingham to the west of Chester, half-way between Manchester and Liverpool, through Wigan and Lancaster to Carlisle ; the third being over the London and South-Western Railway to Basingstoke, through Andover and Salisbury to Exeter and Plymouth, each route having branches at various points from the main circuits ; whilst similar extensions, on a smaller scale, have been made in Scotland, Ireland, and other places. A number of three-wire submarine cables for service under water have also been provided for the use of the Channel Isles, the Isle of Man, and the Orkney and Shetland Islands, whilst new poles to the extent of 850 miles have been erected upon the public roads in England, apart from the extension of wire on the railways and canals. Upon these poles, in addition to the present 11,600 miles of wire already put up, no less than 9,200 miles of new wire, making a grand total of 20,800 miles, or a distance fully covering 100 journeys to and from Carmarthen, in Wales, and Paddington, have been erected. At the various offices in London, and the districts of London, where pneumatic tubes take the place of working by wire, an additional four miles of tubing will be further used to meet the pressure, and for which purposes a large and new tube-room, into which they are now being laid and removed, has been specially prepared in the basement of the Central Telegraph Office. The additional number of telegraph instruments purchased to meet the contingency, should any arise, are no less than 40 Wheatstone automatic, of the latest and most improved pattern, capable of telegraphing upwards of 300 words per minute, eight quadruplex, 300 duplex sounders, 350 single current sounders, 150 single needle instruments, and ten repeaters, in addition to the duplex system which will be completed in the case of 100 circuits. To work this enormous increase the staff in the United Kingdom will be augmented to the extent of 1,200 new telegraph clerks, and over 1,000 messengers. The extra expenditure in connection with these extensive preparations is calculated at £500,000, of which amount £475,000 has been spent on new poles, wires, instruments, &c., whilst £25,000 has been laid out in the building and extension of new offices, many of which have been rebuilt during past two or three years.

ELECTRIC LIGHTING IN THE UNITED STATES.

By CHARLES LEVER.

SIX years ago a few Brush arc lamps, strung up in Broadway, comprised all the electric lighting that New York could boast of. At the present time there are nearly 3,000 arc lights in operation every night in the cities of New York and Brooklyn. Although a vast number of these arc lights, which are fixed upon poles about 30 feet high, are employed for street lighting, by far the greater number are used for illuminating the exterior and interior of stores, saloons, theatres, and other places of amusement. These lights are supplied on the rental system, the usual charge being 40 cents to 45 cents per lamp per night, and they are chiefly run for advertisement. They are principally put up and operated by two companies, the Brush Company and the United States Company. The former, working the Brush patents, is the largest arc-lighting company in the States, the United States Company coming second. Their lamps are so well known that it is unnecessary to describe them here. They are both differential clutch lamps ; but whilst the Brush Company use an E.M.F. of 45 volts per lamp, with a 9 or 10 ampère current, the United States Company works with an E.M.F. of 30 volts per lamp, with a 20 ampère current. Overhead wires conduct the current to these lamps, which dangle about everywhere. Frequently one of these electric light wires comes into contact with a telephone or telegraph line in such a way that a dozen telephone or telegraph instruments are burned in consequence ; but of course this is "an accident." In a few days all business is resumed, everything proceeding as before.

The arc lamps supplied for advertisement outside the various stores, theatres, saloons, &c., are strung up very carelessly—so much so, that if we were to put them up here in the same manner the probability is that a policeman would request us to take them down again. The Americans, however, are an intensely practical people ; and so long as they get the light they are satisfied.

A rather amusing feature in connection with this supply system is that whether a 10 ampère or 20 ampère current is used, the same conductor is employed, generally a No. 4 (American gauge) copper wire, covered with cotton.

Madison and Union Squares are lighted by Brush lamps on the tower system, but this system is practically a failure. Eight lamps in each case are placed about 150 feet high, and are probably of 4,000 nominal candle-power each—say 2,000 actual candle-power. If the same lamps were placed lower down in different parts of the squares the lighting would be infinitely better.

Besides the lights supplied on the rental system and those employed in the streets, a large number of isolated plants on the Brush, Weston, Thomson-Houston, Hochhausen, Fuller, and other systems are in operation, the respective plants being bought out-and-out by the customers. Such installations are to be seen almost everywhere, and the systems are all well known in this country, with the exception, perhaps, of the

"Fuller" light. This is a clockwork lamp, after the style of Hochhausen, although its behaviour is not nearly so good. The Fuller Company have adopted the Gramme dynamo as their generator. An installation on this system is to be seen at the Erie depôt in Jersey City.

The Pennsylvania depôt in Jersey City is lighted by Brush arc lamps, but the railroad company has recently purchased a plant for working some Weston incandescent lamps, which will replace Brush arc lamps in the waiting-rooms. The Elevated Railroad companies seem to be undecided as to whether the arc or incandescent lamps answer best. In the down-town stations Edison and Weston incandescent lamps are chiefly used, although some stations are still lighted by gas; whilst the Brush and Weston arc lamps light some of the up-town stations. Single-carbon lamps are almost exclusively employed in lighting theatres, stores, saloons, &c., the double-carbon lamps being used for public lighting.

The finest specimen of arc lighting to be seen in New York is the lighting of the Brooklyn bridge with Weston lamps. Here the conductors are out of sight, and the installation is exceedingly neat. In fact it would be a thousand pities if this magnificent structure was marred by the presence of unsightly wires.

Practically, electric lighting in New York and Brooklyn is a monopoly, as it is evidently in the hands of the Brush, United States, and Edison companies. The Edison central station in Pearl Street has been described over and over again, so it will be unnecessary to go into any details here. The large Edison steam dynamos are also well known, so it will suffice to say that there are about eight of these 1,400 (fourteen hundred) lighters in operation, a few others being kept in reserve. Although this was the first experimental station for the supply of incandescent lights on a large scale, yet the company manages to pay a dividend of 4 per cent. on the capital invested. With the new type of Edison dynamos, and the improved lamps, the same station could probably be put up to-day at one-fourth the original cost. Indeed, the Edison Company claims that it can erect a lighting station, supply the lights at the same price as gas, and earn a dividend of 20 per cent. on the capital invested. This company shortly expects to have another lighting station in operation in the up-town part of the city. It should be stated that the Edison Company charge their customers for the current consumed, which is registered by meter. These meters, which consist of two zinc plates immersed in a solution of zinc sulphate contained in a glass bottle, are collected at stated intervals and replaced by others. Two assistants are constantly employed at the central station testing the same. The zinc plates are accurately weighed, the current consumed calculated from the mean of the weights which one zinc plate has gained and the other lost, and the account sent in accordingly, In order that the zinc plates may last a long time, the current is reversed from time to time in its passage through the meter.

The Edison machine works in Goerck Street is well worth visiting. About twelve months ago my good friend Mr. Charles Batchelor returned from France to New York, and accepted the management of this works. Since he has been there the Edison machine has undergone a number of improvements. In fact, there is no incandescent light dynamo in this country which can vie with these improved Edison machines in workmanship or efficiency. The relative quantities of copper wire and iron which should be used in the field magnets and armature has been so thoroughly worked out and experimented upon, that it would be almost impossible to improve upon the results now obtained. The field magnets throughout, including the yoke, are made of wrought iron of the best quality. They are very much shorter than even in Dr. Hopkinson's modification, and a great mass of iron is used in the field magnets with a surprisingly small quantity of copper wire. In a word, these new Edison dynamos are almost perfection. Another company which supplies incandescent lights is the United States Company, who use the new Weston incandescent lamp with the celluloid filament. This lamp gives out a very pleasant and agreeable light, and is already in extensive operation. The Hoffmann House and other hotels and restaurants in New York City are lighted on this system, Weston shunt-wound dynamos supplying the current.

At Coney Island the bulk of the lighting seems to be done by the Excelsior Company owning the Hochhausen system, although a few other well known arc lamps are also to be seen. Some of the steamers which run from New York to this celebrated watering place are also lighted by Weston and other arc lamps. By far the finest specimen of electric lighting on board a ship is to be found on the palace steamer, *Pilgrim*, of the well-known Fall River Line. This installation has been carried out by the Edison Company of New York, several hundred lamps being used. The electroliers and fittings are simply exquisite in design and finish. How different from the disgraceful fittings on board some of our Atlantic steamers! During the evening performance on board the *Pilgrim*, by the steamer's orchestra, an exceedingly pretty effect was produced by means of an Edison lamp of 100 candle-power, placed on the floor in the centre of the orchestra. All the light in the saloon being turned out, with the exception of a group of lamps at the end of the saloon opposite to the orchestra, a piece called "The Forge in the Forest" was performed. Along with the brilliant music anvils were made to clink, whilst the light of the forge was exceedingly well represented by the continued flashing of the 100 candle-power lamp, which, being hidden from the audience, exhibited a strange and weird effect in the partly darkened saloon. It is, perhaps, needless to say that the piece was enthusiastically encored.

(To be continued.)

THE BRITISH ASSOCIATION.

(Specially Reported for the "Electrical Review.")

THE RELATIVE MERITS OF IRON AND COPPER WIRE FOR TELEGRAPH LINES.

By W. H. PREECE, F.R.S.

COPPER is gradually replacing iron for aerial telegraphs owing to its greater durability in the atmosphere, but its greater cost has led to the use of smaller sized wires. This can be done without detriment to the economy of the line, for the resistance of copper as compared with iron varies very nearly inversely as its price per ton, and hence the cost per mile remains about the same. Hitherto only short lengths have been erected in smoky towns, and through districts where chemical industries filled the air with gases destructive to iron wires; but the Post Office Telegraph Department has recently erected a No. 14 copper wire, ·080 inches in diameter, weighing 100 lbs. per mile, all the way from London to Newcastle, 278·08 miles in length, and it became desirable to measure very accurately its electrical elements, so as to see if it possessed, as was anticipated, any marked advantages as a telegraph line over the galvanised iron wires hitherto used.

There were two series of experiments made. In the *first* series the relative electrical condition of the two kinds of wires was determined; and in the *second* series their relative rates of working.

The first series, the results of which are given in Tables I., II., III. and IV., was divided into two parts; the one consisting of tests made from Bishop Auckland to Teams, near Newcastle, a distance of 30·235 miles, on the north side, and to Pierce Bridge, a distance of 9·172 miles, on the south side; and the other consisting of tests of a section of line between Pierce Bridge and Baldersby Cross Roads, 26·7 miles in length. The poles carried 10 wires. The tests were made in dry and favourable weather by Messrs. Kempe and Eden.

The electrostatic capacity of an aerial line is known to vary as

$$\log. \frac{4h}{d}$$

where h is the height of the wire above the ground, and d its diameter. Now the average height of the copper wire on the sections between Bishop Auckland and Teams, and between Pierce Bridge and Baldersby Cross Roads is 23 feet, and that of the iron wire (on a lower arm of the pole) 22 feet; their diameters being

TABLE I.—TESTS OF COPPER AND IRON WIRES ON ROAD LINE BETWEEN BISHOP AUCKLAND AND TEAMS TERMINAL POLE. 19*th July*, 1885.

Designation of Wire.	Material.	Gauge.	All wires disconnected except one on lowest arm. Capacity. Microfarads. Total.	Per mile.	All wires to earth except one under test. Capacity. Microfarads. Total.	Per mile.	Conductor resistance. Ohms. Total.	Per mile.	Insulation resistance. Megohms. Total.	Per mile.	REMARKS.
No. 241	Copper	14	·400	·0132	·436	·0144	278·7	9·21	2·709	81·90	Weather fine. Temperature 66° Fahr. in the shade. Length of section tested 30·235 miles.
„ 242	Iron	7½	·444	·0146	...	...	346·4	11·45	2·483	75·08	
„ 243	„	„	·458	·0151	...	...	345·0	11·41	1·146	34·65	
„ 330	„	„	·450	·0148	...	...	345·4	11·42	2·295	69·30	
„ 245	„	„	·447	·0147	...	...	345·6	11·43	·513	15·51	
„ 329	„	„	·447	·0147	·510	·0168	345·9	11·44	2·292	69·30	
Newcastle-Liverpool 3 ...	„	„	·440	·0145	...	...	346·2	11·45	1·655	50·04	
Cardiff-Newcastle ...	„	„	·440	·0145	...	...	347·0	11·47	1·862	56·30	
Leeds-Newcastle 2 ...	„	„	·461	·0152	...	...	346·7	11·46	1·862	56·30	
Manchester-Newcastle 2	„	„	·449	·0148	...	...	347·0	11·47	2·128	64·34	

TABLE II.—TESTS OF COPPER AND IRON WIRES ON ROAD LINE BETWEEN BISHOP AUCKLAND AND PIERCE BRIDGE. 19*th July*, 1885.

Designation of wire.	Material.	Gauge.	All wires disconnected except one on lowest arm. Capacity. Microfarads. Total.	Per mile.	All wires to earth except one under test. Capacity. Microfarads. Total.	Per mile.	Conductor resistance. Ohms. Total.	Per mile.	Insulation resistance. Megohms. Total.	Per mile.	REMARKS.
No. 241	Copper	14	·112	·0122	·128	·0139	85·9	9·36	5·730	52·56	Weather fine. Temperature 66° Fahr. in the shade. Length of section tested 9·172 miles.
„ 242	Iron	7½	·125	·0136	...	...	116·5	12·70	4·515	41·41	
„ 243	„	„	·123	·0134	...	...	116·6	12·71	2·980	27·33	
„ 330	„	„	·127	·0138	...	...	114·9	12·52	4·655	42·70	
„ 245	„	„	·128	·0139	...	...	113·7	12·40	2·709	24·85	
„ 329	„	„	·128	·0139	·151	·0164	113·9	12·41	3·460	31·73	
Newcastle-Liverpool 3 ...	„	„	·130	·0141	...	...	122·5	13·35	3·725	34·17	
Cardiff-Newcastle ...	„	„	·132	·0143	...	...	114·6	12·50	4·806	44·08	
Leeds-Newcastle 2 ...	„	„	·132	·0143	...	...	113·7	12·40	4·515	41·41	
Manchester-Newcastle 2	„	„	·128	·0139	...	...	114·7	12·50	variable		All the other wires were disconnected when the capacity of this wire was measured.

TABLE III.—TESTS OF COPPER AND IRON WIRES ON ROAD LINE BETWEEN PIERCE BRIDGE AND BALDERSBY CROSS ROADS. 26*th July*, 1885.

Designation of Wire.	Material.	Gauge.	All wires disconnected. Capacity. Microfarads. Total.	Per mile.	All wires to earth except one under test. Capacity. Microfarads. Total.	Per mile.	Conductor resistance. Ohms. Total.	Per mile.	Insulation resistance. Megohms. Total.	Per mile.	REMARKS.
No. 241	Copper	14	·319	·0119	·377	·0141	243·5	9·12	1·488	39·732	Weather fine. Temperature 76° Fahr. in shade. Length of section tested 26·7 miles.
„ 242	Iron	7½	·345	·0129	...	...	327·8	12·27	·893	23·850*	
„ 243	„	„	·341	·0127	...	...	326·9	12·24	1·030	27·502	
„ 330	„	„	·342	·0128	...	...	326·6	12·23	·382	10·200	
„ 245	„	„	·351	·0131	...	...	326·5	12·23	1·116	30·973	
„ 329	„	„	·352	·0131	·451	·0169	327·2	12·25	·670	17·892*	
Liverpool-Newcastle 3 ...	„	„	·361	·0135	...	...	326·9	12·24	·346	9·238	
Cardiff-Newcastle ...	„	„	·361	·0135	...	...	327·1	12·25	·670	17·892*	
Leeds-Newcastle 2 ...	„	„	·350	·0131	...	...	326·8	12·24	·893	23·850	
Manchester-Newcastle 2 .	„	„	·350	·0131	...	...	327·3	12·25	·893	23·850	* Variable.

TABLE IV.—TESTS OF NEW NORTH ROAD WIRES BETWEEN PIERCE BRIDGE AND BALDERSBY CROSS ROADS.—26*th July*, 1885.

INDUCTION BETWEEN WIRES.

Primary Current Wires.	Induced Current Wires.	Galvanometer deflections. Divisions.	Equivalent in micro-coulombs.	Primary current-coulombs per second.	Distance between primary and secondary wires. inches.	REMARKS.
Nos. 242 and 243	Nos. 330 and 245	20	·0892	·0456	12·8	Weather fine. Temperature 76° Fahr. in the shade. Resistance of galvanometer, 6700ω. Resistance of looped wires, 654ω. Resistance of battery (30 Daniell cells), 150ω. In each case the value of the induced current given is the mean of several measurements.
„ „ „ „	No. 329 and {Liverpool-Newcastle}	10	·0446	„	24·0	
„ „ „ „	{Cardiff-Newcastle} and {Leeds-Newcastle}	5	·0223	„	36·3	
„ 330 „ 245	Nos. 242 and 243	20	·0892	„	12·8	
„ „ „ „	No. 329 and {Liverpool-Newcastle}	20	·0892	„	12·8	
„ „ „ „	{Cardiff-Newcastle} and {Leeds-Newcastle}	5	·0223	„	36·3	
„ 329 „ {Liverpool Newcastle 3}	Nos. 330 and 245	20	·0892	„	12·8	
„ „ „ „	Nos. 242 and 243	5	·0223	„	36·3	
„ „ „ „	{Cardiff-Newcastle} and {Leeds-Newcastle}	20	·0892	„	12·8	

TABLE V.—MEAN RESULTS OF SPEED TRIALS ON COPPER WIRE BETWEEN LONDON AND NEWCASTLE-ON-TYNE.
July, 1885.

Experiment.	Sending power. Bichro. cells.	Current passing through receiving instrument. Milliamperes.	Form of Receiving Apparatus.	Arrangement of coils.	Speed—Words per minute. Simplex. To London.	Simplex. From London.	Duplex. To London.	Duplex. From London.	Compensating Capacity. Microfarads. Duplex.	Microfarads. Simplex.	REMARKS.
A.—1 to 4 ...	40	12·3	Weight, Wheatstone receiver; res. of coils, 100 ω each.	series	400	414	...	...	...	3·5 to 4	Weather fine, with occasional showers
B.—5 to 8 ...	„	„	Ditto	quantity	400	414	...	...	...	12 to 16	
C.—9 to 15 ...	„	„	Ditto	...	...	...	265	273	Newcastle 2·75 to 3 G.P.O. 5 to 5·25		
D.—16 to 20 ...	„	„	Relay with coils similar to those in receiver; receiver in local circuit	series	400	414	...	...	...	3·5 to 4	
E.—21 to 25 ...	„	„	Ditto	quantity	400	414	...	...	...	12 to 16	
F.—26 to 32 ...	„	„	Ditto	...	...	...	265	273	as in C		
F. F.	„	„	As in expts. A, B and C, but res. coils and condenser inserted at York in order to make the copper and iron wires alike in res. and capacity	...	400	414					
G.—33 to 40 ...	„	„	P.O. standard relay; receiver in local circuit	series	340	350	...	...	...	4·5	
H.—41 to 46...	„	„	Ditto	quantity	340	350	...	...	...	14 to 18	
I.—47 to 50 ...	„	„	Ditto	...	...	...	240	250	as in C		

Length of line (including 17·08 miles of underground work) ... 278·08 miles.
Diameter of wire ... ... ·08 in.
Resistance per mile ... ... 9·1 ω.
Capacity per mile ... ... ·0141 m.f.
Insulation resistance per mile varied from 3 to 30 megohms.

TABLE VI.—MEAN RESULTS OF SPEED TRIALS ON IRON WIRE BETWEEN LONDON AND NEWCASTLE-ON-TYNE.
July, 1885.

Experiment.	Sending power. Bichro. cells.	Current passing through receiving instrument. Milliamperes.	Form of receiving instrument.	Arrangement of coils.	Speed words per minute. Simplex. To London.	Simplex. From London.	Duplex. To London.	Duplex. From London.	Compensating capacity. Microforads. Duplex.	Microforads. Simplex.	REMARKS.
K.—50 to 57...	40	12·3	Weight, Wheatstone receiver; res. of coils 100ω each	series	333	340	...	...	...	3·5 to 4	Weather fine, with occasional showers.
L.—58 to 65...	„	„	Ditto	quantity	333	340	...	...	...	12 to 16	
M.—66 to 76...	50	6 to 15	Ditto	series	350	...	...	...	...	...	Various combinations of res. and capacity tried.
	„	„	Ditto	quantity							
O.—79 to 82...	40	12·3	Relay with coils similar to those in receiver. Receiver in local circuit	series	354	360	...	...	...	as in K	
P.—83 to 89...	„	„	Ditto	quantity	354	360	...	...	...	as in L	
Q.—90 to 95...	„	„	Ditto	...	...	...	231	243	Newcastle 2·75 to 3·25 G. P. O. 5·25 to 5·5		
R.—96 to 105	„	„	P. O. standard relay with receiver in local circuit	series	300	310					
S.—106 to 112	„	„	Ditto	quantity	300	310					
T.—113 to 120	„	„	Ditto	...	...	...	214	224	as in Q		
N.—77 and 78	„	„	Wheatstone receiver; res. of coils 100ω each ...	...	...	...	231	243	as in Q		

Length of line (including 6 miles of No. 14 copper wire, and 17·08 miles of underground work) ... ... 278·08 miles.
Diameter of iron wire ... ... 171 mils.
Resistance „ „ ... ... 12·15ω per mile.
Capacity „ „ ... ... ·0169 „ „
Average insulation resistance 20 megohms per mile.

·080 inch and ·171 inch respectively. We have therefore for copper wire

$$\log. \frac{4h}{d} = \log. \frac{4 \times 23 \times 12 \times 1000}{80} = 4{\cdot}1398791;$$

for iron wire

$$\log. \frac{4h}{d} = \log. \frac{4 \times 23 \times 12 \times 1000}{171} = 3{\cdot}7906678$$

and

$$\frac{3{\cdot}7906678}{4{\cdot}1398791} = {\cdot}916, \text{ nearly,}$$

which makes the capacity of the copper wire to be 100—91·6, or 8·4 per cent. less than that of the iron wire.

This result agrees pretty closely with the mean value of the differences of capacity obtained by actual measurements on these sections, viz., 9·1 per cent.

For the Bishop Auckland-Pierce Bridge section we have :—

For copper wire

$$\log. \frac{4h}{d} = \log. \frac{4 \times 21 \times 12 \times 1000}{80} = 4{\cdot}1003705$$

For iron wire

$$\log. \frac{4h}{d} = \log. \frac{4 \times 20 \times 12 \times 1000}{171} = 3{\cdot}7492751$$

and

$$\frac{3{\cdot}7492751}{4{\cdot}1003705} = {\cdot}914,$$

making the capacity of the copper wire to be 100—91·4, or 8·6 per cent. less than that of the iron, whilst the actual value was found to be 9·7 per cent. The differences between the calculated and the experimental values are probably due to the influence of trees, buildings, &c., which cannot be allowed for theoretically. These measurements were made when the other wires on the poles were left insulated. The effect of having all the other wires to earth when the capacity of any one wire was measured was very marked. Thus, on one wire the capacity was increased from ·352 to ·451 microfarads or 22 per cent. It would, therefore, appear that the mean capacity per mile of a single iron wire of ·171 inches diameter placed about 20 feet above the ground is ·0131 microfarads, while an iron wire of the same size suspended at the same height, but surrounded by other wires forming telegraphic circuits, would have a mean capacity of ·0169 per mile. The capacity of this copper wire under similar conditions would be about ·0120 and ·0142 microfarads per mile, respectively.

As regards the induction between wire and wire tests the effects obtained were very slight, though their actual value was determined with comparative accuracy.

The second series of experiments was conducted between London and Newcastle, and were designed, as stated above, to test the working efficiency of the copper wire as compared with iron wires. They were conducted by Messrs. Chapman and Eden. The results of the numerous trials of speed with various arrangements of the apparatus are given in Tables V and VI, and are summarised in Table VII.

TABLE VII.—COMPARATIVE SPEEDS OBTAINED ON COPPER AND IRON WIRES UNDER SIMILAR CONDITIONS.

(Summary of Tables V. and VI.)

Words per Minute.								Average increase of speed on copper wire.
Iron.				Copper.				
Simplex.		Duplex.		Simplex.		Duplex.		
To London.	From London.	To London.	From London.	To London.	From London.	To London.	From London.	Per cent.
333	340	...	...	400	414	...	...	21
...	...	231	243	...	...	265	273	11·36
354	360	...	...	400	414	...	...	11·40
...	...	231	243	...	...	265	273	11·36
300	310	...	...	340	350	...	...	11·31
...	...	214	224	...	...	240	250	11·19
Mean result of all experiments								12·9

It will be observed that copper shows a very decided superiority over iron, the speeds being as follows :—

	Copper.	Iron.
Simplex working ...	... 414 ...	345 words per minute.
Duplex „ ...	... 270 ...	237 „ „

It is anticipated that the superiority of copper over iron indicated by these experiments will have a beneficial and economical influence on our telegraph system, and that its extended use will enable us not only to work better, but to dispense with intermediate repeaters in many cases where, on long lines, they are now necessary.

The most interesting point, however, in connection with these experiments is that they apparently prove that the superiority of copper is not simply due to its smaller electrostatic capacity and resistance, but that it is more susceptible to rapid changes of electric currents than iron; for when the resistance and capacity of the copper and iron wires were equalised by the insertion of resistance coils and condensers, the speed on the former was not thereby diminished. Possibly the magnetic susceptibility of the iron is the cause of this. The magnetisation of the iron acts as a kind of drag on the currents. It is well known that telephones always work better on copper than on iron wires, doubtless for the same reason.

These experiments also show the high speed of working that is now attained with the Wheatstone automatic apparatus. The following table gives an interesting *résumé* of the different stages of the progress made by the Post Office authorities and its rate of growth.

1877	...	...	...	80 words per minute.
1878	...	...	...	100 „ „
1879	...	...	...	130 „ „
1880	...	...	...	170 „ „
1881	...	...	...	190 „ „
1882	...	...	...	200 „ „
1883	...	...	...	250 „ „
1884	...	...	...	350 „ „

DOMESTIC ELECTRIC LIGHTING.

By W. H. PREECE, F.R.S.

(Section G.—Mechanical Science, September 14th).

AFTER referring to the full details of the lighting installation of his house in Wimbledon, given to the section at the meeting at Montreal, Mr. Preece referred generally to the experiences he had gained during the past 12 months. The secondary batteries upon which he had mainly relied exceeded his expectations in the services they rendered. They returned 70 per cent. of the energy put into them without any apparent diminution whatever in their E.M.F. They showed no signs of deterioration, and gave no trouble whatever. He used his gas engine for charging only two days a week. He had experienced no fault with the wiring of his house. He had used only the very best materials, and had attended personally to the insulation of the system. It was periodically tested, and found to be good. He referred in severe terms to the cheap and nasty wire which was so frequently and ignorantly used, and feared that the prejudice against the electric light would increase when failures from this cause arose. None but the very best materials should be used, and the joints should be seen to by experts. He had devoted considerable attention to the problem of distributing light, and had succeeded so far that while his rooms were beautifully illuminated, the eye was not irritated by regarding a bright source of light. The lamp he used was a 50 volt 10 candle-power glow lamp, and it was as a rule so fixed that the eye never saw it. He had arrived at the use of these lamps after careful consideration and many trials of other lamps. They secured greater safety in the leads, and involved less capital in batteries through the use of low E.M.F.

He ran his lamps at an E.M.F. about 2 per cent. less than the normal E.M.F. He did this to secure long life to his lamps. The breakage had been very small. The E.M.F. and current which will give a lamp a normal life of 1,000 hours and a certain candle-power, should be determined by every maker. The sixth power of the current will give the candle-power, and the twenty-fifth power the life with any other current. The great advantage of batteries is, that the proper current once determined can never be exceeded, and thus efficiency is ensured. If lamps are run too low there is a waste of power, if too high there is waste of lamps. We are now gradually acquiring a thorough knowledge of the number of watts which should be expended in each lamp to secure the maximum economic efficiency.

He had introduced into the charging lead, and into the discharging lead, a Ferranti meter, so that he was able to record exactly the quantity of electricity passed through the batteries and that passed through the lamps. This beautiful meter is based on Ampère's laws which determine the attraction and repulsion of currents. A small phosphor-bronze vane is immersed in a bath of mercury through which the current flows radially fixed in a magnetic field. The mercury rotates and carries with it the vane. The rate of rotation varies directly with the strength of current, and the number of rotations are recorded by a counter, which can be read off directly. So far he was perfectly satisfied with its performance. As regards expense, excepting the first cost, he did not find much addition to his expenditure for illumination. His electric light was costing him about £50 a year, for gas, wages, oil, and lamps. It was the cheapest luxury he indulged in. The great advantages were the comfort and cheerfulness it engendered, and as cheerfulness was the main element of health, he thought that the electric light would prove a serious rival to the doctor. There was no one who valued health and comfort who should neglect to apply the electric light to his home, when it was brought, as it has been by the success of the secondary batteries, within his means. It was said that he as an expert could make things go which would fail in ordinary hands, but he mentioned several cases where coachmen, butlers, gardeners and grooms had been found perfectly competent and intelligent enough to attend to everything.

As regarded the cost of the installation of the light, it would be

about £7 10s. for each lamp, assuming that a lamp took the place of each of the existing gas burners. A house that it took £400 to fit up with the light, would probably require about £40 or £50 a year to maintain it in efficient working order.

Discussion.

Mr. Swan, as one who also had experience of lighting his house by electricity, bore testimony to the advantages of the light. It was cheerful and cleanly, and could be introduced at a moderate cost. It could be managed without any technical knowledge whatsoever, and only so much of it need be used in a room as was pleasant to the occupants of that room.

The Lord Advocate pointed out the advantage of the electric light over gas in respect that, unlike gas, it was not injurious to pictures and books, and he believed, too, that it would tend to make curtains and carpets last longer and save the bills of house painters.

The discussion was continued by Sir James Douglass, Professor Forbes, and Captain Douglas Galton.

A gentleman in the audience expressed his regret that no gas engineers had come forward to take part in this discussion and vindicate the interests of gas. The electric lighting gentlemen were apparently in force, and he thought that they had had too much of their own way. He thought it a pity that no one had given a comparison of the average cost between gas and electricity in their domestic applications.

Mr. Preece, replying to the remarks which had been made, said the question of using gas as a ventilating agency was a very important one. He did not want to say one word against the use of gas; he was a gas shareholder himself. Gas had an enormous field as a means of producing power and generating heat—a greater field, indeed, than the electric light—and it still had a function to perform as a kind of secondary agency to the electric light. At the present moment he was engaged in an experiment which he hoped would have a very important result—the lighting by electricity of Lloyd's rooms in London. Gas had hitherto been used there both for light and ventilation. They were not going to remove gas as an illuminant, but to leave it as a means of ventilation. Very careful experiments would be made to see how far gas could be used as a ventilating agent and how far it could be dispensed with.

REMARKABLE OCCURRENCE DURING THE THUNDERSTORM OF AUGUST 6th LAST, AT ALBRIGHTON.

By J. Bedford Elwell.

St. Cuthbert's, my residence, is situated at Albrighton, ten miles from Wolverhampton, with which it is connected by telephone. The house has a lightning protector 25 years old. The telephone wire very improperly makes earth on this conductor.

The storm was at its height about half-past eight in the evening, and we had just retired to the drawing room, there being only a single lamp left alight in the dining room, in the centre of the corona. The telephone bell was sounding with every flash of lighting, when suddenly a report like a rifle shot was heard in the hall, and at the same instant the servants in the dining room were plunged into darkness by the lamp in the corona flashing up and then going out (another lamp was immediately put in, showing the leads were not injured); also, at the same moment, the telephone wires were both fused. The wire sometimes used to connect the telephone with the drawing room was also fused, and through it the lightning tried to make earth (or *vice versâ*) all over the electric light system, succeeding in one place, in a bed room over the entrance hall, where a bell pull was close to one of the leads. The current struck across, showing an E.M.F. of many thousand volts, and fused the bell wire. None of the lead cut-outs were fused on any of the wires.

On examining the burnt lamp in the dining room, it was found to be so blackened that (although it was perfectly clear and bright the moment before, and being a 48 volt Swan lamp, could not be over-run from 24 cells), it was with difficulty that the filament could be seen. It was burnt off at *both ends* where the platinum wire joined and *lay entire* in the bottom of the globe. A few globules of melted glass or platinum were also rolling about within the globe.

The glass globe has become a beautiful mirror by the fine particles of platinum that have been projected against it.

N.B.—A *separate earth plate* has since been put to the telephone, so that nothing of the kind can again happen.

ON THE GENERATION OF A VOLTAIC CURRENT BY A SULPHUR CELL WITH A SOLID ELECTROLYTE.

By Shelford Bidwell, M.A., LL.B.

(*Section B.—Chemical Science.—September 14th.*)

While observing the secondary or polarisation currents which are generated by sulphur cells (as by those made with selenium) after being disconnected from a battery, certain effects were noticed which seemed to indicate that when the electrodes consisted of two different metals, a sulphur cell might be capable of originating an independent or primary current. Experiments were therefore made with the object of investigating this point, and some of the results obtained are here given, though without any attempt to explain them, or to connect them together by a complete theory. They appear, however, to possess sufficient interest to render them worthy of record, from the fact that no voltaic arrangement with a solid electrolyte has hitherto been constructed which, at least at ordinary temperatures, was capable of producing the smallest effect upon the most delicate galvanometer.

A plate of copper about one inch square was heated, and upon it was spread a mixture consisting of five parts of sulphur and one part of sulphide of copper. A plate of silver previously heated was then laid upon the melted mixture, and the two plates squeezed together, thus forming a sandwich-like cell. When this cell, after cooling, was connected with a reflecting galvanometer, the spot of light was violently deflected off the scale. From very careful measurements it appeared that the electromotive force of the cell was ·0712 volt, and its internal resistance 6537 ohms. The direction of the current was from the silver through the electrolyte to the copper, and there could be no doubt that it was of a voltaic nature. After the cell had been in existence for about three months its electromotive force had not materially fallen off.

The current was small, owing to the great internal resistance of the cell, and attempts were made to reduce this resistance by diminishing the proportion of free sulphur. But it was found that when the resistance was reduced in this manner the E.M.F. was also diminished, and when there was nothing but pure copper sulphide between the plates, there was no E.M.F. whatever.

Another cell was made in which powdered silver sulphide without any free sulphur was compressed between plates of silver and copper. This arrangement generated a current, the direction of which was opposite to that produced by the cells above described; but the E.M.F. rapidly fell off, and in three or four days had almost completely disappeared.

When a similar cell was made, in which the silver sulphide was mixed with sublimed sulphur, and placed in the form of a powder between the plates, the direction of the current was, as with simple silver sulphide, from copper to silver. But if the mixture was first fused, and the plates between which it was compressed heated, the current generated by the cell when cold was in the reverse direction. Sulphide of copper was undoubtedly formed in the process of construction.

Consideration of these results led the author to believe that the sole function of the free sulphur in the copper sulphide cell was to form a film of silver sulphide by direct combination with the silver plate. A cell was therefore made as follows:—A layer of copper sulphide was spread upon a plate of copper; a polished steel plate was laid upon the sulphide, and the whole was strongly compressed in a vice. The steel plate was then removed, and a thin layer of silver sulphide was spread upon the smooth surface of the copper sulphide. The cell was completed by pressing a silver plate upon the silver sulphide. This was found upon trial to give a current which, with an external circuit of low resistance, was many times stronger than that generated by any of the cells previously made. Its action was probably analogous to that of a Daniells cell consisting of plates of zinc and copper in solutions of zinc sulphate and copper sulphate. The quantity of the copper sulphide would be gradually diminished, copper being deposited on the copper plate; while the quantity of the silver sulphide would continually increase with consumption of the silver.

A very curious effect observed in the course of the experiments was the following:—If a battery current was passed for a short time through a cell consisting of two silver electrodes imbedded in a mixture of sulphur and copper sulphide, the cell, after being disconnected from the battery, generated a current of very short duration (not impossibly due to thermo-electric action) in the direction opposite to that of the battery current; and this current, which rarely lasted for more than two or three minutes, was followed by another which was in the *same* direction as the battery current, and was generally maintained for several hours.

ON A SPECIMEN OF ALMOST UNMAGNETISABLE STEEL.

By J. T. Bottomley, M.A., F.R.S.E.

(*Mathematical and Physical Section.*)

The author has examined a specimen of steel presented to Sir William Thomson by Mr. R. R. Eadon, of the firm of Moses Eadon and Sons, Sheffield. This steel is made under Hadfield's patent, and contains 15 per cent. of manganese, and one side of the specimen bar has been polished, and shows that the steel is capable of taking a very high finish. The present specimen has probably a tensile strength of 45 tons to the square inch. To test it magnetically the bar was first "touched" with steel magnets, and such preliminary seemed to show that the magnets had not the slightest effect upon it. It was then placed between the poles of a powerful Rhumkorf electro-magnet, which was excited by 40 large tray Daniells, arranged in fours for quantity and ten in series; and the process for magnetising, which is always used in the Glasgow University laboratory, and which is very satisfactory, was proceeded with. It was very astonishing to find the bar of steel absolutely unaffected by the electro-magnet, so far as could be perceived by the hand.

After magnetisation the bar was tested carefully by the magnetometer method, which consists in placing the magnet to be tested at a known distance from a very short suspended magnet in a known position, the suspended needle being in a place where the earth's horizontal force is accurately known, and by the deflection of the magnetometer, comparing the force of the bar with that of the earth.

With the bar in the position shown in the diagram, the formula for calculating the magnetic moment of the bar is as follows:

$$\mu = H \frac{2d}{(d^2 - l^2)^2} \tan. \theta.$$

where μ is the magnetic moment, H is the horizontal force, d distance of centre of bar from centre of magnetometer, $2l$ the effective length of bar, and θ the angle of deflection. A minor magnetometer being used and the deflection being very small, tan. $\theta = \theta$; and θ is equal to half the number of scale divisions of the deflection divided by the distance in scale divisions of the scale from the magnetometer.

In the present instance the effective length of the bar has been estimated at 10 centims., the real length over all being 14·29 centims. The value of it is very accurately known at a certain place in the Glasgow University laboratory. The experiment on this bar gave for the magnetic moment: $\mu = 2{\cdot}55$. The weight of the magnet is 192·09 grammes. Hence the magnetisation per gramme of this specimen of steel is—

$$\frac{2{\cdot}55}{192{\cdot}09} = 0{\cdot}013 \text{ C.G.S. per gramme.}$$

To compare this with other specimens of steel, we find in many specimens that magnetisation of 40, 50, or even 60 C.G.S. per gramme can be obtained. In some specimens as much as 90 or even 100 C.G.S. per gramme has been obtained.

P.S.—The author has been informed that Dr. Hopkinson has already experimented on steel containing manganese, and has obtained similar results. He has not, however, seen Dr. Hopkinson's figures, and is unable to compare his own results with them.

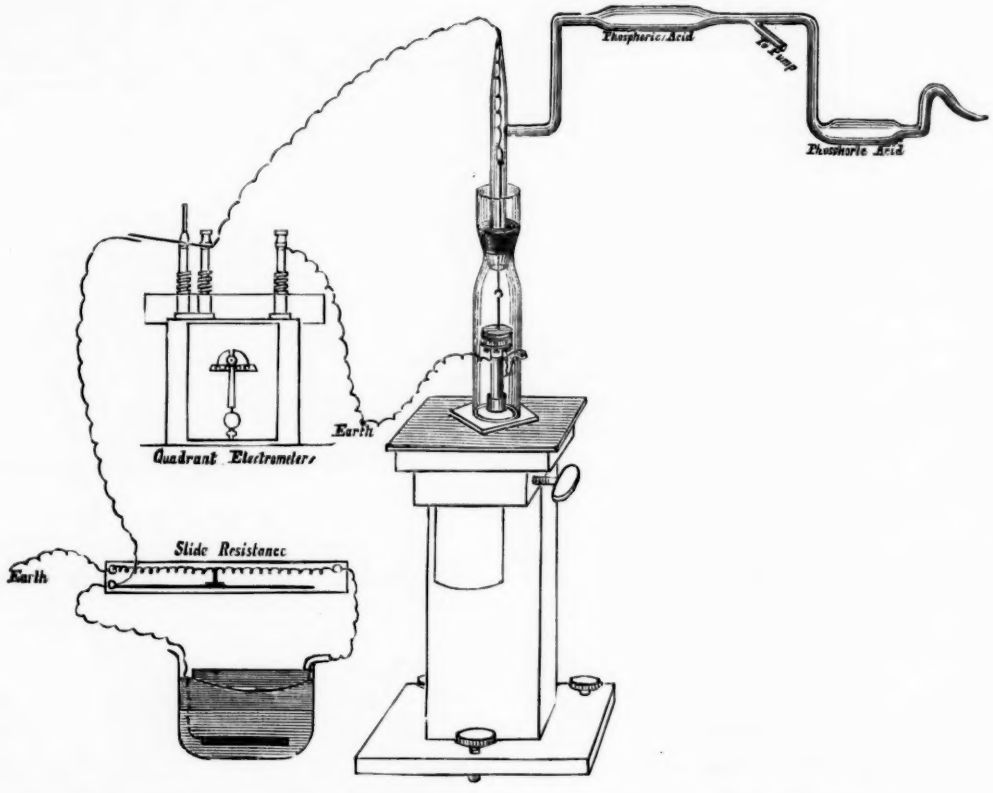
must have brought forcibly before the minds of those interested in the subject the extremely unsatisfactory state of our experimental knowledge on some of the fundamental questions relating to contact electricity.

Foremost among these, perhaps, is the question of the behaviour of various metals as to Volta contact effect in air and vacuum, and in gases different from common air. I have undertaken a series of experiments on this subject, and have already obtained some definite results, although the experiments which I have made up to this time are only to be considered as preliminary to a fuller enquiry.

The apparatus which I am using is shown in the diagram. The lower of the two plates to be experimented on is supported in the vacuum chamber by a small stand with a glass pillar; and the electrode from this plate passes through the side of the chamber, hermetically sealed into it. The upper plate is hung from the top by a long platinum spiral, the upper end of which is also hermetically sealed into the glass. To the lower end of the spiral is attached a long hook which carries the lower plate, and at the junction of the spiral with this hook there is a small globe of soft iron. It is by means of this small soft iron globe, and a magnet applied outside the tube, that the upper plate is lifted from the lower plate. The nature of the vacuum chamber, and its connection to the pump, will be readily understood from the diagram. The final adjustment of distance between the two plates when at their nearest is done at the top of the tube by heating it and drawing out the glass carefully, or else letting it fall in till the adjustment is satisfactorily made. The branch tube on the right hand side of the diagram, which is shown sealed off, is used for admitting gases to the apparatus. A small part only of the drying and purifying apparatus is shown in the diagram.

For determining the value of the volta contact effect, I have used the quadrant electrometer and the compensation method of Sir William Thomson. The Daniells cell and slide resistance and the connections are shown in the figure. The method is so well known that it need not be described here.*

The plates which I have used are zinc and copper discs a little larger than a shilling. Testing them first with full air pressure, I found that that the Volta contact difference was rather over 0·74 volt, which is as nearly as possible what has been found by previous experimenters, and by myself experimenting a few weeks ago with Sir William Thomson's old contact apparatus.



CONTACT ELECTRICITY IN COMMON AIR, VACUUM, AND DIFFERENT GASES.

By J. T. BOTTOMLEY, M.A., F.R.S.E.

(Section A.—Mathematical and Physical Science, September 10th.)

THE discussion at the British Association meeting at Montreal last year, as the seat of electromotive force in the voltaic cell, the paper of Prof. O. Lodge which resulted from that discussion, and the subsequent discussion at the Society of Telegraph Engineers,

The air was then very carefully exhausted, the exhaustion being maintained for two days, and finally made exceedingly good with 2½ hours work at the pump just before testing. The pressure during the testing was not greater than, and was probably much less than, $\frac{1}{2\frac{1}{2}}$ mm. of mercury or 2·8 M (2½ millionths of an

* It was described in *Nature*, April 14th, 1881; and has also been described in the paper of Prof. O. Lodge, which was printed in the B.A. reports and elsewhere.

atmosphere). The electrical test was then applied. and the value of the volta contact effect was found to be *exactly the same as before*, a little over 0·74 volt. The final test, however, consisted in allowing the air to come back into the apparatus, and then testing electrically. This was done by breaking the point of the sealed tube to the right of the diagram; and as the air entered the electrometer test was rapidly applied. So far as the sensitiveness of the testing apparatus goes, there was absolutely no change in the volta contact difference.

My experiments, therefore, are absolutely contradictory, so far as they have gone, to those of Dr. W. von Zahn, quoted by Prof. Lodge, who experimented in a high vacuum and found the Volta effect to be diminished, and to be represented by a potential difference of only half a Daniell.

I have also experimented on hydrogen and oxygen gases in this apparatus in a way precisely similar to that described above. The chamber was very carefully exhausted and the Volta contact effect tested with the electrometer. Hydrogen was then admitted, and while it was entering, which it was forced to do slowly, the electrical testing was repeated several times. A second and a third exhaustion were made and hydrogen admitted a second and a third time. The same was subsequently done with oxygen, except that it was of course sufficient to admit the oxygen a single time. The result of my investigation so far as it has gone, is that the volta contact effect, so long as the plates are clean, is exactly the same in common air, in a high vacuum, in hydrogen at small and great pressure, and in oxygen. My apparatus and the method of working during these experiments was so sensitive that I should certainly have detected a variation of one per cent. in the value of the Volta contact effect if such a variation had presented itself.

To do away with all question as to the dependence of the Volta effect on "ancient air sheets," I propose to modify my apparatus by making the vacuum chamber much longer and finally of combustion tubing. I shall then apply great heat to the plates while they are contained in a vacuum as high as I can command. If then there be any ancient air sheets existing they must either be driven off or else absorbed into the plates. If any gas be driven off it will be removed by the pump. The plates will then be tested when they have perfectly cooled and the value of the contact difference determined. That being done, the atmospheric air or some other gas will be admitted and the contact difference will be again determined. The effect of the presence of the atmosphere or other gas will, I think we may safely suppose, be thus ascertained.

In conclusion, I have to express my indebtedness to Mr. J. Rennie, assistant to the Professor of Natural Philosophy in the University of Glasgow, for most valuable assistance during my investigation.

DISCUSSION.

Prof. EWING said that Mr. Bottomley's experiments on the manganese steel seemed to relate entirely to permanent magnetisation, and asked whether Mr. Bottomley had made any determination as to magnetic inductive force.

Mr. BOTTOMLEY said that he had not made any measurement of non-permanent magnetisation. He might say, however, that during the application of the bar to the electro-magnet there was not the slightest sensation of attractive force to be perceived by the hand.

Mr. W. H. PREECE said he had a piece of the metal sent him, and he tested it, but could find no distinct feature in it; it gave somewhere about the resistance of iron or steel.

Lord RAYLEIGH said a paper read by Dr. Hopkinson before the Royal Society in the spring, referred to this manganese steel. His (Lord Rayleigh's) impression was that this metal was much more non-magnetic than that of which Dr. Hopkinson spoke. He believed the latter was investigating the point, and his paper was not yet published in full. In the present instance the absence of temporary magnetism seemed to be almost as surprising as the absence of permanent magnetism.

The PRESIDENT, in asking the section to accord a hearty vote of thanks to Mr. Bottomley for his papers, remarked that it was very much to be desired that he should be able to get absolute measurements on this subject, so as to be able to get some idea of the relations between radiation and temperature, and of radiation as a function of absolute temperature for which some theoretical foundation had been given by Professor Tait in his recent book on heat. It would be a very remarkable fact if the law he spoke of there could be established theoretically and experimentally.

[The papers read by Mr. Bottomley, including that in our last week's issue, as well as the discussions thereon, should be taken together, as, by an error, they have become wrongly distributed.—EDS. ELEC. REV.]

ELECTRICITY CLASSES.

Manchester Technical School.—At this institution a large number of candidates are prepared for the examinations of the City and Guilds of London Institute, and, we believe, furnished on the occasion of the last competition the first prizeman for both telegraphy and electric lighting. The department of electrical engineering and physics is under the superintendence of Dr. A. B. Griffiths, F.R.S. (Edinburgh), F.C.S., and Mr. E. L. Rhead. There are elementary and advanced courses of lectures on magnetism and electricity on Monday and Thursday evenings, fully illustrated by experiments, and Mr. Rhead also conducts a laboratory class for the performance of the principal experiments illustrating the subjects of magnetism, electricity, and heat, together with instruction in the making of electrical apparatus. Fees for each course of lectures, 2s. 6d.; for laboratory, 5s. A special class for the preparation of candidates for the technological examination is conducted by Mr. W. S. Harrison in telegraphy, and another by Mr. J. Poole (electrician to the Lancashire and Cheshire Telephone Exchange Company), in the principles of electrical engineering.

Royal College of Science for Ireland, Dublin.—This college supplies a complete course of instruction in science applicable to the industrial arts, and also prepares teachers for local schools of science. During the first term, extending from October to January, a special course of lectures on applied electricity, accompanied by laboratory demonstrations, are given by the professor of physics, Prof. W. F. Barrett, F.R.S.E., M.R.I.A.; the fee for the course being £4.

University College of South Wales and Monmouthshire, Cardiff.—The session begins on October 6th. The professor of physics, who is also principal, the Rev. J. Viriamu Jones, M.A. (Oxon.), B.Sc. (Lond.), Fellow of University College, London, conducts classes of candidates for the matriculation examination of the University of London, as well as for the intermediate examination in science and the preliminary scientific examination. The laboratory is well stocked with apparatus, electricity being specially provided for. The sessional fee for the lectures is £3 3s., and for the laboratory from £3 3s. upwards. This institution, although very recently established, has got well into working order, and the success of candidates for matriculation proceeding from it to the University of London has been much above the average.

University College, London.—The complete curriculum for students of electrical engineering extends over four years, the course being as follows:—First year, graphical statics, junior mathematics, elementary mechanics, junior physics, chemistry, surveying; second year, senior mathematics, dynamics, practical physics, practical chemistry, geology, junior engineering, engineering drawing, senior physics; third year, higher senior mathematics and mathematical physics, chemistry (special class), physical and engineering laboratories, and lectures on electrical technology; fourth year, chiefly electrical work in the physical laboratory, with the continued study of mathematical physics. Prof. J. A. Fleming, M.A., D.Sc., and M.S.T.E., is at the head of the department of electrical technology, and the fee for this course alone is £4 4s. for the session.

College of Science and Arts, Glasgow.—This institution continues to turn out a large number of successful candidates for the various examinations, a large proportion of whom are evening students who are in situations of various kinds during the day. The summary of results of the science examinations in 1885 shows the total number of certificates gained by students from this College of Science and Art to be 377 first-class and 406 second class; 578 being in the elementary stage, 186 in the advanced stage and 19 in the honours stage. Principal Jamieson, C.E., F.R.S.E., M.S.T.E., &c., conducts the electricity and electrical engineering classes under the City and Guilds of London Institute, and instructs day pupils in the principles and practice of electrical engineering and instrument making, along with the use of scientific instrument maker's tools and appliances. A three years' course of study qualifies for the diploma in electrical engineering. The fees to students who go forward to the examinations are on a very moderate scale. The classes open on 5th October.

Mason Science College, Birmingham.—In connection with the physical laboratory course a series of experiments will be arranged, specially adapted to persons desirous of studying the practical applications of electricity. This will include, in addition to the experiments of the physical laboratory course, measurements

of resistance, electromotive force and currents, experiments illustrating the principles of dynamo machines, testing of a dynamo, measure of work done in lamps and of the light given, use of the dynamo as a motor, testing of telegraph lines for faults, &c. The fee for six hours per week for the session is £4. In the case of more advanced students opportunities will be afforded for original research. Opening day 1st October.

The Yorkshire College, Leeds.—Professor. W. Stroud, D.Sc., B.A., gives three courses of lectures on physics, two of which consist of two experimental lectures and an exercise class weekly throughout the session. The third course consists of two experimental lectures weekly during the session. The first year course is framed to meet the requirements of candidates for the matriculation examination of the University of London; the second to meet the requirements of candidates for the intermediate B.Sc. and preliminary scientific (M.B.) examination of the University of London; and the third to meet the requirements of candidates for the B.Sc. examination of the University of London. For the first and second year the fees amount to £3 13s. 6d. for each course, and for the third year £2 12s. 6d. There are also evening courses with special reference to the City and Guilds Institute, the fees being 10s. 6d. for the lectures and 30s. for the laboratory. All the classes in the department of science, technology, and arts are now held in the new buildings recently opened by the Prince and Princess of Wales. Session commences 6th October.

Bradford Technical College.—Classes are conducted by Mr. J. T. Riley, B.Sc. (Lond.), in magnetism and electricity, on Wednesday evenings, commencing 16th September; the fee for each course to students going forward to the examination being 5s.

Young Men's Christian Association, 186, Aldersgate Street, London.—Mr. H. Parkins holds a class in magnetism and electricity on Thursday evenings, commencing 1st October, the course being designed to meet the requirements of the elementary and advanced stages of the Science and Art Department, and is specially adapted to meet the wants of telegraph clerks and of others who are engaged in electrical work, and who require a Government certificate of their knowledge and proficiency. The fee per course to members is 5s., and to non-members 7s. 6d. (conditional on sitting for the examination in May).

ELECTRIC LIGHTING ON THE STAGE.

THERE are several reasons why the grand spectacular ballet, "Excelsior," which has been running at Her Majesty's Theatre for over 100 nights, should possess more than ordinary interest for electricians and our scientific readers generally. In the first place, it is a picturesque record of the continual progress of science in its various departments, the main theme observable through the eleven gorgeous tableaux being the triumph of Light over Darkness. Then there are brought upon the stage certain contrivances which have a peculiar attraction for that portion of the scientific community for which this journal delights to cater. Towards the close of the first act Light makes her appearance in the Abode of Genius and Science, with the emblem of her influence, represented by a specially-constructed portable arc lamp of about 2,000 C.P., held gracefully aloft; and the rising of the curtain on one of the scenes in the next act discloses Volta at work in his laboratory at the moment of his important discovery, which is vividly portrayed by the aid of the electric current supplied from the lighting machinery, a real electric spark being shown by means of a very simple apparatus. And then there is an important installation of the electric light upon the stage for general illuminating purposes, presenting many novel features, perhaps the most important of which is the simple and practical manner in which the installation has been carried out and the total absence of resistances, switch boards, and everything else of a complicated nature.

As long ago as May 5th of the present year we intimated that Mr. Shepherd, who founded the Edison Company in Italy, and also introduced the Brush system into that country, had been entrusted with the electric lighting arrangements in connection with the representation of the ballet; and we have now to chronicle an entire success in a branch of electric lighting which is bound in good time to become one of considerable importance, but which at present enjoys the distinction of being almost an unexplored field.

There have been attempts made at stage lighting by means of incandescence lamps, but the installations have been for the most part of a transitory character, the very large number of lamps required to produce an adequate effect, and consequently the great expense, necessitating a return to less costly if less effective illuminants. But in the present instance Mr. Shepherd, who, it may be here mentioned, is the contractor alike for the lime light and electrical arrangements, has succeeded in maintaining for a period of over four months an installation of arc lights which has given unqualified satisfaction upon every point. It is rather surprising in this connection, however, that in the advertising arrangements a special feature is not made of so important an innovation. Press and public have been unanimous in their praise of the brilliancy of the ballet, the superiority of the electric light to the lime light ordinarily used being universally admitted, while, moreover, we are informed that it is found to be cheaper.

Those who know aught of stage architecture and mechanism, and the very limited space of which use is not made, will readily recognise the difficulties which have to be encountered in any considerable installation on "the boards;" and Mr. Shepherd is to be congratulated upon his success in overcoming these. He has an 8 horse-power Clayton and Shuttleworth engine driving a Maxim-Weston dynamo situated in that portion of the stage which is termed the "elephant hole," this position necessitating 70 feet of chimney for the engine, in order to meet the requirements of the fire insurance offices. Ten arc lamps (Maxim-Weston) are employed, five placed between the wings on either side, and these are fitted with special reflectors to concentrate all the light upon the stage. Mr. Shepherd's large experience in illumination on the stage and out of doors in Italy has stood him in good stead in dealing with the many difficulties of a practical nature, and he has in thorough working order an installation which is charming the public by its scenic effects, has met with the approval of Mr. Musgrave Heaphy, the all-powerful in regard to precautions against fire, and has given such satisfaction to the lessees of the theatre, Messrs. Boracchi and Corti, who are also lessees of La Scala Theatre, Milan, that they desire him to furnish 30 arc lights for the scenic effects of a new ballet being expressly composed for them by the Chevalier Manzotti, author of "Excelsior," which is to be produced at La Scala on Boxing Night, and which is intended to surpass everything hitherto attempted in the way of spectacular performances.

The arc lamp carried across the stage by Light is of Mr. Shepherd's own construction, and he claims to be able to regulate it to produce any light up to 4,000 C.P. The arc is enclosed in a large glass globe. It is a novelty in this country, and is certainly most effective and appropriate to the subject. The Volta spark arrangement was devised by Mr. Shepherd's nephew, E. F. Moy, a lad of sixteen, who acts as his assistant and bids fair to make his way in this business.

The Uses of Search Lights.—Whilst H.M.S. *Dreadnought* was exercising her electric search lights at Malta a short time since, an engine-room artificer fell overboard, the sea being rather choppy at the time. By means of the electric search lights the poor fellow was seen struggling in the water near a life-buoy, but unfortunately he sank before the boat could reach him.

NOTES.

Electric Lighting and Torpedo Trials. — The Hon. Guy Dawnay, Surveyor-General of Ordnance, Major-General Sir A. Clarke, and several other officers were present at some trials of the Brennan torpedo at Sheerness on Thursday, the 17th inst. The torpedo, which attained a speed of about 20 knots, was run a second time after dark, being steered into the beam thrown by the electric light.

The Thomson-Houston System.—The Northern Electric Company of Philadelphia (Thomson-Houston system), has recently added two new 45-light machines, and the capacity of the plant is now increased to 200 arc lights. Great improvements are being made in the city of Bloomington, Ill., amongst which is included the installation of the electric light by the Thomson-Houston Company, which has made provision for 150 lamps.

The Electric Light at Plymouth.—The interior of the Drill Hall at Plymouth has just been fitted with the electric light according to the Thomson-Houston system, the work having been carried out by Messrs. Laing, Wharton and Down, the sole British agents. The Thomson-Houston system is particularly suited for lighting large and lofty places, and is generally approved of at Plymouth, where the most sanguine anticipations have been more than realised. The interior of the Drill Hall is illuminated with eight lamps of 2,000 candle-power, there being also another at the entrance, and a tenth at the entrance to the grounds, while above all hangs a veritable lighthouse, dispensing its rich gleams of light far and wide. Mr. Gutter is the electrician in charge, and he has been present to explain to those desiring such information the various details of the system, an important feature of which is the automatic regulator, by means of which lamps can be lit and extinguished without the slightest attention being paid to the generating plant, and quite independently of any irregularities of engine speed. Every detail of this system, as our readers are aware, has been exhaustively described in the REVIEW.

Gas v. the Electric Light.—At a meeting of the Hove (Sussex) Commissioners a few days ago, a discussion took place with reference to the lighting of the Esplanade lawns, the Works and Improvements Committee recommending that tenders should be invited for providing and fixing gas lamps. Mr. Woodruff, in moving the adoption of the recommendation, remarked that several members of the board were in favour of the electric light, but having studied the matter, he was of opinion that it was too costly for them at present. The surveyor stated in answer to a question that the 36 lamps required would cost a little over £4 per annum each for lighting if they were turned out soon after midnight. Mr. Clark said that if they expended £1,000 on the electric light instead of £470 on gas lamps, they could work it afterwards for something like £200 per annum, and the light would be incomparably better. He thereupon moved an amendment in accordance with the tenor of his remarks, and this was duly seconded. Mr. Cheesman said that those who were in favour of the electric light would soon alter their opinion if they went over to Eastbourne, where perfect darkness prevailed 20 yards from a lamp. Eventually the recommendation of the committee was confirmed.

Lighting at Stockport.—Messrs. Durham and Co., of Stockport, during the latter part of last week illuminated the west part of the town with arc lights, the current being supplied by Gramme machines. This was on the occasion of local festivities, and so pleased were the committee with the result that we understand the above firm has secured the next year's contract for a still larger display. Messrs. Durham and Co. have also just completed the fitting up of the Stockport Great Schools with Woodhouse and Rawson incandescent lamps.

Electric Lighting in Italy.—The city of Palermo will shortly be lighted by electricity, and it is said that one of the principal firms there has arranged with the International Electric Company for this installation. The machinery will be shipped at New York by the *Gottardo*, one of the steamers of the Italian Navigation Company. The experiments recently made for lighting the tunnel at the Col di Tenda have been successful, and it has been decided to light it definitely by electricity. The Cruto incandescent lamp has been introduced in South America, and it is to be adopted in the lighting of several establishments at Montevideo. This lamp has been selected by the Municipality of Turin for the lighting of part of the city, and a public trial of the illumination of the arcades *viâ* Po was made by order of the authorities last month.

Induction.—It seems from statements at the Telephonic Convention in America, that a new source of induction in telephone lines is the third rail introduced in the street car line upon which the Daft motor is being run at Baltimore.

A "Submarine Telephone."—"For some time past it has been whispered in the electrical world that instruments were in course of construction that would solve the problem of telephoning across the ocean through any of the great Atlantic cables." This is the preface in a contemporary to a wonderful story, which has also been related in many other contemporaries, of a 'cute Texan, "entirely unknown to science," who has solved the problem of long distance telephony across seas and oceans by the very simple method of enlarging the instruments ordinarily used for telephonic purposes. We would like to learn from this unscientific genius how far a transmitter as large, say, as St. Paul's Cathedral would convey the sound of the human voice. Two or three times round the world, perhaps?

The Dolbear Telephone Case.—This case, in which the claim is made on behalf of Dolbear that Bell did not invent the telephone, is to come up on appeal before the United States Supreme Court next spring.

The Telephone Contests in America.—The National Improved Telephone Company, which is to be the next adversary of the Bell Telephone Company, has invoked the aid of the Government in the contest, and has secured that aid. The stand taken by the National Improved Company is that Bell was not the original inventor of the telephone. Mr. Lockwood, of the Bell Company, at the recent Telephone Convention, refering to the litigation, asserted that the company never felt more secure regarding its patents than it does at the present time.

Strike of Telegraph Operators.—According to exchanges, it is rumoured that another strike will shortly take place among the telegraph operators of New York.

Boycotting in Ireland.—A telegram was recently sent to the caretaker of a farm in county Roscommon, Ireland, but the postal authorities were unable to procure its delivery, as the man was "boycotted," and the messengers refused to go to him.

New Telegraph Station in China.—A telegraph station has been opened at Chefoo, China, and the rate by the Great Northern Telegraph Company's lines from all stations in the United Kingdom is 10s. per word.

The Telegraph Conference.—The Telegraph Conference, which sat, off and on, for more than a month, was closed on the 17th inst. Paris was selected as the capital for the next Conference in 1890. The decisions of the Conference just closed will only come into operation on the 1st of next July, but the reduction of Press messages to and from Australia (from 6s. 5d. to 2s. 8d. per word) will probably take effect in January.

Suggested International Cable System.—The *Times* correspondent at Berlin communicates the contents of a very important letter from Sir James Anderson to Herr von Stephan. Sir James Anderson sketches out a scheme for the taking over by the Governments of the world, by means of a great council representing the nations of the world, of the cables owned by the submarine cable companies. In an interesting paper which he has had compiled he points out that the twenty-six cable companies own a total length of 98,450 miles, their capital being £34,459,089, with a reserve fund of £3,148,695, and gross annual revenue of £3,477,082, and their percentage of dividends as follows :—Anglo-American, 3½ ; American Telegraph and Cable, 5 ; Black Sea, 4 ; Brazilian Submarine, 6 ; Télégraphe de Paris à New York, 4 ; Central American Cuba Submarine, 8 ; Direct Spanish, *nil* ; Direct United States, 5 ; Eastern, 6 ; Eastern and South African, 8 ; Eastern Extension, 7 ; German Norwegian, 5½ ; German Union, 8 ; Great Northern, 8 ; Hamburg Heligoland, *nil* ; Mexican (no information published) ; Montevidean and Brazilian, *nil* ; Platino-Brazileira, 1¼ ; River Plate, 15 ; Submarine, 14 ; West Indian and Panama, *nil* ; Western and Brazilian, *nil* ; West Coast of America, 4. Sir James Anderson does not desire a continuance of cable contests. He says that if the Governments of the world take over the cables the number of lines of communication can be increased to any desired extent, and the tariff reduced to any figure, so as to make "the foreign trade of the world an extended home trade," common alike to all nations. For this end the proposal is that the maritime States, or all the States in some agreed proportion, should guarantee a moderate interest upon the present capital of the companies and take over and work the cables by a Telegraph Board of Management. It is not to be thought of that Great Britain or any one or two States should buy up or control the cables, because there are concessions granted to companies which would not be given to foreign Governments, and there are jealousies among States as well as among individuals. No plan will come to any practical result unless it is international, and it is not thought that any great difficulty will be experienced in formulating some plan if the principle be accepted. It would cost the nations of the world no money, and all the increment could go to the extension of cables and the reduction of tariffs. It is believed that Herr von Stephan is in favour of this proposal, but some considerable time must elapse before it can attain a practical form.

Cables for the West Coast of Africa.—The steamship *Silvertown*, owned by the India Rubber, Gutta Percha, and Telegraph Works Company, arrived at the moorings off the company's works at Silvertown on Tuesday last, and is now being loaded with 1,350 nautical miles of cable. This cable will unite the Cape Verde Islands with various points along the West Coast of Africa, and will also connect these points with the Spanish National Submarine Telegraph Company's system at St. Louis (Senegal). The cable now being shipped is the first instalment towards the completion of telegraphic communication along the West Coast of Africa, under concessions granted by the Portuguese and French Governments. The present intention is, starting on the one hand from the Cape Verde Islands, and on the other from St. Louis, to establish stations at Dakar (Senegal), at Bolama and Bissau (Portuguese possessions about 250 miles to the south of Bathurst), and at Rio Nunez or Conakry (French settlements), the latter being about 80 miles to the north of Sierra Leone.

The Daft Electric Motor.—Private experiments have been made on the New York Elevated Railroad with the Daft electric motor. The electric circuit is made from the dynamo to the central rail, through the collector to the motor, thence to the wheels and rails, and back to the dynamo.

The Commercial Cable.—The *Financial News* remarks :—"John W. Mackay and James Gorden Bennett are said to have done more than any other two men to lessen the evil influence of Jay Gould. The Commercial Cable is the sharpest thorn in Gould's side."

The New Telegraph Regulations.—The revised regulations relating to postal telegrams, which have just been issued in anticipation of the sixpenny rate arranged to come into operation next Wednesday, will not, in the view of the *Standard*, raise the reputation of the postal authorities either for style or for business capacity. Some of the regulations are of the most trivial and irritating kind, while many of the rules and illustrations are so worded as not only to allow but almost to invite misconstruction. A little extra trouble—say half-an-hour spent in the correction of proofs—would have provided against the latter, and a few months' experience will cause a clean sweep to be made of most of the former.

The Distribution of Electricity.—Dr. Fleming has favoured us with a communication on the subject of Dr. Hopkinson's paper "On a Possible Danger in connection with Secondary Generators." As the latter's views will have obtained wide circulation through our journal, it is very important that the public should know that a simple remedy exists for the possible danger, and that Dr. Fleming has applied it to the secondary generators the Edison and Swan Company are exhibiting at the Inventions.

Gas not Infallible.—Shortly before eight o'clock the other night all the public and private gas burners in Bangor were suddenly extinguished. For a space of fully ten minutes the town was in complete and utter darkness, the result being that business people despairingly closed their establishments. Some sort of patching up was done at the gasworks, but with poor effect ; even at 9 o'clock the public lamps had an illuminating power equal only to that of a rush light. At the hotels and public-houses the burners were turned off, and replaced by paraffin lamps or candles.

The Mining Exhibition, Glasgow.—This exhibition continues to attract large numbers of visitors. The electric lighting installations are amongst the foremost attractions, and call forth unfeigned commendation.

Overhead Wires in Edinburgh.—Last week the Plans and Works Committee of the Edinburgh Town Council had under consideration the subject of overhead telephone and telegraph wires, and a model of a system for laying them underground was examined.

Engineering Amalgamation.—We understand that an amalgamation has been arranged between the old established firm of R. and W. Hawthorn & Co., engineers, of Newcastle-on-Tyne and St. Peter's-on-Tyne, and the well-known firm of Andrew Leslie & Co., shipbuilders, of Hebburn-on-Tyne, with a view to the formation of a joint stock company of the private limited form. Upon the termination of the partnership hitherto existing between Mr. A. Leslie and Mr. Arthur Coote, Mr. Leslie retires from the business, the new company absorbing his interest. We are informed that the title of the firm will be R. & W. Hawthorn, Leslie & Co., Limited.

British Association.—The following grants of money, among others, have been appropriated to scientific purposes by the General Committee :—Mathematics and Physics.—Electrical standards, £40 ; solar radiation, £20 ; meteorological observations at Chepstow, £25 ; instructions for tidal observations, £50 ; comparing and reducing magnetic observations, £40 ; standards of light, £20 ; Ben Nevis Observatory, £100 ; physical and chemical bearings of electrolysis, £20. Chemistry. —Silent discharge of electricity into atmosphere, £20 ; chemical nomenclature, £5. Mechanics.—Effect of varying stresses on metals, £10. The total amount of grants was £1,195.

The Umbrella and Compass again.—In connection with the extraordinary incident which took place some weeks ago on board the Stranraer and Garrie steamer *Princess Beatrice*, whereby the compasses of the steamer were perceptibly affected by the proximity of a steel "ribber" umbrella, Captain George Campbell of the steamer writes detailing a repetition of the affair by the presence of another passenger and his umbrella. He says: As the original occurrence reported in the papers seems to have been received in rather a sceptical spirit, and in fact generally disbelieved, I am glad to be in a position to verify it. On Friday evening, when crossing from Larne to Stranraer, the same disturbance of the compass was observed, and it was discovered to be due to the proximity of an umbrella carried by Mr. J. Dickson, of Larchmoor, near Slough. As in the previous case, a thorough investigation was made, and it was found that the umbrella was also highly magnetised. Over a dozen umbrellas belonging to other passengers were tried, but none of them affected the compass in the smallest degree. What is singular is that both Mr. Dickson's umbrella and the one now in my possession, and which formerly belonged to Mr. J. Smith Gardiner, of Dublin, are of the same make, both marked "paragon" on one of the stays, and bearing a representation of a fox running. The occurrence was witnessed by a great number of passengers, and at my request Mr. Dickson furnished me with a certificate, of which I send a copy. I do not write this for the purpose of amusing the public, but rather in the interests of the public safety, and as a warning to men in my position not to allow passengers to congregate about the steering compass, especially in foggy or dark weather, else some day they might find themselves out of their reckoning and perhaps ashore. I am afraid that in that case the umbrella theory would receive scant appreciation at a Board of Trade enquiry. I may mention that I spoke of this occurrence to two compass adjusters, who both refused to believe that an umbrella could have such an effect until Mr. Moore, of Belfast, satisfied himself as to the accuracy of my statement.

Ashton Court Lighting.—Respecting the supply of cables for this installation, Messrs. Walter T. Glover and Co. write as follows:—"In your issue of September 12th, we notice a letter from the Henley Company relative to the supply of cable for this installation; we understood from the engineer in charge of the work that all the wire and cable was being ordered from us, otherwise we should not have sent you the notification we did. As a matter of fact we supplied 7/18, 7/16, 19/14 and 19/12 cables, and No. 10 and No. 16 single wire. From the size of the installation we think the Henley Company must have known that what they supplied was only a small portion of what was required. We are content to leave your readers to judge of their letter on its merits."

Compound Wound Dynamos.—We have given in our other columns particulars which are certain to prove of more than ordinary interest to makers of compound dynamos. From such of our readers as may desire additional information on this very important matter we would invite correspondence or a visit. We understand that the Anglo-American Brush Corporation has engaged the services of several of the eminent counsel who have so successfully fought for the Bell and Edison patents, but to steer clear of the prior patent to which we have referred will prove a "teazer" even for them.

Leicester Sanitary Exhibition—We understand that this exhibition is lighted by means of arc and incandescent lamps, the installation being effected by Messrs. Woodhouse and Rawson.

Electric Railway at Toronto.—Mr. Van Depoele has successfully started the electric railway at Toronto, using a Van Depoele motor.

Wire Gauges.—A motion was brought forward at the recent convention of the American Telephone Exchange Association to adopt the English standard wire gauge, in order to be in uniformity with European nations. It met with strenuous opposition from several members, who thought the American gauge was all that was required, but it was eventually agreed to.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Mexican Gas and Electric Light Company, Limited.—The annual return of this company, made up to the 14th inst., was filed on the 16th. The capital is £100,000, in £20 shares, the whole of which has been fully subscribed by nine members. Mr. Albani John Henry Gibbs, of 15, Bishopsgate Street Within, is the proprietor of 4,993 shares, and each other member is the holder of one share.

Bernstein Electric Lamp Company, Limited.—An agreement dated 1st August and filed on the 17th inst., provides for the purchase by this company of the letters patent No. 2,604 of the year 1882, No. 6,075 of the same year, and No. 3,915 of the year 1883, relating to improvements in incandescent lamps, and patents for Belgium, Denmark, Sweden and Russia. The purchase consideration is the payment to Mr. Alexander Bernstein of a royalty of 2½d. for every lamp constructed by the company, or under license from the company.

New Electro Amalgamator Company, Limited.—The registered office of this company is at 4, Token-house Buildings, E.C.

CITY NOTES, REPORTS, MEETINGS, &c.

The Electric "Sun" Lamp and Power Company, Limited.

THE third ordinary general meeting of this company was held at Cannon Street Hotel on Tuesday, Mr. W. Perkins presiding.

The attendance of shareholders was small.

Mr. Boardman, the secretary, having read the notice convening the meeting,

The Chairman moved the adoption of the directors' report and accounts. The report, which was taken as read, was as follows:—

"The circumstances under which we accepted office in January of last year will be in your recollection. At the general meeting then held the original directors recommended that the company should be wound up, but after a long discussion you decided that some further attempts ought to be made to render the undertaking a commercial success. At that meeting you also appointed four directors, but as the articles of association require that there shall be at least five, those four elected Mr. Brereton (a large shareholder) to complete the board. Mr. Javal, one of the directors appointed by you, filled the office of chairman for twelve months, when he resigned, in consequence of his whole time and attention being required in an enterprise he had joined. Mr. Perkins was then elected chairman by us, and Mr. Charles Fortescue Brickdale was elected to fill the vacant seat at the board.

"On assuming office we first turned our attention to reducing the office and working expenses. We gave up the offices at Westminster, and transferred the business of the company to the works in Ridinghouse Street, where there was sufficient room and accommodation for the staff, and we accepted for our own remuneration about one-fifth of the amount allowed by the articles of association.

"Our next step was to push the business as vigorously as possible, and to this end we appointed a manager who had been very successful in working up telephone business, and a traveller who had had great experience of the "Sun" lamp from the time it was first introduced. We issued a descriptive pamphlet, and appointed agents in nearly every important place in the United Kingdom. Manufactories, theatres, clubs, shops, restaurants, music-halls, and similar places were canvassed with a view to selling installations to them, and also with a view to establishing central stations from which to supply electricity and work our lamps; in short, we tried every means to make the lamp as great a commercial success as it is now proved to be a scientific and practical one. But the public has not responded, and the consequence is that after a trial of upwards of eighteen months we are

reluctantly compelled to come to the conclusion that until the Board of Trade adopt the modifications and changes in the Electric Lighting Act, suggested by the Electric Lighting Act Committee in their report of March last, we cannot hope to succeed. We have found that the general public are unwilling to incur the heavy expenses of separate private installations, however good the systems may be; and the restrictions of the present Act effectually bar the employment of capital for the installation of works for a general supply of electricity; and it is quite certain that had gas, when first introduced, been hampered with the same restrictions which have been imposed upon electric lighting, it never could have survived them or have attained its present great success. In fact, our field for work is reduced to such a small compass, that we regret to say we cannot see our way to make the undertaking sufficiently profitable to continue it.

"At the time we assumed office we hoped the Government would so modify the Electric Lighting Act as to make it workable, and with these hopes we set to work to canvass many districts in London with a view to establishing one or more central stations, and from the promises we obtained we should have been warranted in incurring the expense of a central station had the Government seen fit to grant the facilities which are needed to assist the introduction of a new enterprise. As they have not done so, we do not see any immediate prospect of carrying on the business of the company profitably; and, although the accounts show a profit of £662 upon the business we have done, yet the expenses of works, offices, salaries, &c., have necessarily been as heavy as if we had done one hundred times the amount of business, resulting in an expenditure at the rate of about £2,765 a year over and above receipts and increase of stock.

"This being the case, we beg to submit for your consideration the advisability of voluntarily winding-up the company. Should you decide to do so, we would advise the immediate division of the cash assets of the company, leaving the stock of lamps, engines, dynamos, and the various appliances for installations to be realised by the liquidators as favourable opportunities arise instead of forcing an immediate sale, which would result in a very heavy sacrifice.

"With regard to the lamp itself, it has now stood the test of upwards of three years in this country, and has proved to be without exception the best and steadiest electric lamp yet invented. During the past eighteen months it has taken two gold and one silver medals, in addition to the gold medal awarded in 1881. We have fitted up installations at the Health and Inventions Exhibitions, at the Grosvenor Gallery, New Bond Street, at Messrs. Robey's at Lincoln, and at the *Manchester Guardian* office; and we have undoubtedly proved its scientific and practical superiority over arc lamps for steadiness and freedom from all objectionable colours. We may here state that a considerable amount of the money expended at the works has been spent in improving the construction of the lamp, and that within the last few months a difficulty which appeared insurmountable has been overcome, for the "Sun" lamp can now be worked with the same dynamos, having sufficient electromotive force, and from the same leads as any arc or incandescent lamps, which, of course, has added to the value of the patent. We, therefore, think that as this lamp has an undoubted value, the patents should not be disposed of with undue haste, as it is quite certain that in the present stagnant state of electric lighting industry it would be difficult, if not impossible, to find a purchaser at an adequate price, whereas when the present unfavourable conditions imposed upon electric lighting companies are removed, the value of the "Sun" lamp, we believe, will assert itself, and a satisfactory realisation may be hoped for.

"Resolutions for the voluntary liquidation of the company will be submitted to you at the extraordinary general meeting to be held in accordance with the notice endorsed hereon, and in the event of their being carried, two of the directors, viz., Mr. William Perkins and Mr. M. I. F. Brickdale are prepared to undertake the duties of liquidators."

The Chairman, in moving the adoption of the report, recapitulated the facts given above, and said, in conclusion, that the Government having not seen fit to give them any facilities for making a success of the undertaking, and the public declining to become producers of the current necessary to light with, he and his colleagues were compelled reluctantly to advise the shareholders to take the course they had suggested, viz., to divide the cash assets and realise the plant and patent as opportunity arose.

Mr. M. I. F. Brickdale seconded the adoption of the report, which was unanimously agreed to.

An extraordinary general meeting was then held for the purpose of considering the following resolution:—"That the company be wound up voluntarily under the provisions of the Companies' Acts, 1862 to 1883, and that William Perkins, of York Villa, Princes Terrace, Bayswater, Esquire, and Matthew Inglett Fortescue Brickdale, of 8, New Square, Lincoln's Inn, Barrister-at-Law, be and they are hereby appointed liquidators for the purposes of such winding up."

The Chairman moved this resolution and Mr. W. H. Brereton seconded it, with the result that it was passed without dissent.

Mr. Duchamps agreed that the course suggested by the directors was the right one, but said he should like to see the name of Mr. Henry De Grelle, vice-consul for Belgium, added to the liquidators, as a large number of the shares were held by Belgian friends, who would be glad for Mr. De Grelle to look after their interests. He submitted a motion embodying his wish, which was seconded by Mr. Clerc and adopted, the meeting thereupon terminating.

The Hammond Electric Light and Power Supply Company, Limited.

THE following circular has been issued by the committee appointed by the shareholders at the meeting of the Hammond Electric Light and Power Supply Company, held in June last:—"Since you appointed us to confer with your liquidator, we have carefully considered the possibility of a resuscitation of your company, and we regret that we are unable to recommend such a course. The large amount of liabilities and claims, about £20,000, and the peculiar nature of the assets, would necessitate an immediate subscription of considerable capital, which we do not feel justified in asking the shareholders to find, nor do we think that in the present state of the electric lighting industry, and the unfortunate results of the past three years' business, there is any disposition to supply capital for this purpose. The assets consist very largely of Brush arc plant and Ferranti dynamos, for which there is but a very limited demand, and the offers received from various persons and companies for the installations and portions of the stock were so absurdly small that we concur with the liquidator that the only course is to sell by a well-advertised auction or public tender. A decision in favour of your company has been given in the Donnithorne and Liardet case, but no money has yet been received. We fear the prospect of any return being made to the shareholders is extremely doubtful. A meeting of the committee will be held at these offices on Monday, September 28th, when they will be happy to meet any of the shareholders desirous of information. The question of the continuation of the committee can then be discussed."

Electric News Telegraph Company, Limited.—A meeting of the shareholders is to be held at 4, Ludgate Circus, E.C., on October 24th, for the purpose of receiving the liquidator's accounts, showing the manner in which the winding up has been conducted and the property of the company disposed of.

Provincial (Brush) Electric Light and Power Company, Limited.—Creditors are required on or before October 3rd, to send particulars to William Henry Pannell, the liquidator of the Company, at 38, Basinghall Street.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 11th were £1,665 after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited. There were two holidays in Brazil during the period.

NEW PATENTS—1885.

10773. "Applying electric light to speculums and other instruments used in medical and surgical examinations of the cavities of the human body." T. P. SALT, A. T. SALT. Dated September 11.

10791. "Protecting against danger from fracture of overhead electric wires." J. G. CHIDLEY. Dated September 11.

10816. "Alternative in and out electric indicator." N. G. THOMPSON. Dated September 12.

10817. "Switch for electric lighting." N. G. THOMPSON. Dated September 12.

10830. "Electrical apparatus applicable for opening or closing gas cocks and the like." W. P. THOMPSON. (Communicated by L. Lenaerts. Dated September 12.

10832. "Electric indicator applicable to gas cocks." W. P. THOMPSON. (Communicated by L. Lenaert and H. L'Ollivier.) Dated September 12.

10841. "Material resembling gutta-percha; making same." F. G. L. TYTLER. Dated September 12.

10877. "Contact makers for electric bells." J. G. LIVESAY. Dated September 14.

10888. "Electric advertising apparatus." E. L. BERRY. Dated September 14.

10891. "Electrical indicators." H. G. ELLERY, J. T. GENT. Dated September 14.

10909. "Galvanometers." J. BLYTH. Dated September 15.

10931. "Method of applying gum balata for insulating wires." P. A. NEWTON. (Communicated by P. C. Matherson and C. W. Torrey.) Dated September 15.

10935. "Electrical conductors." H. J. HADDAN. (Communicated by A. Arndt.) Dated September 15.

10950. "Telephonic apparatus." J. IMRAY. (Communicated by W. Burnley.) Dated September 15. (*Complete.*)

10951. "Electrical receiving apparatus for relay or other purposes. W. P. JOHNSTON. Dated September 15.

10952. "Electrical locking apparatus for the working of trains or double and single lines on railways, and for other purposes." C. E. SPAGNOLETTI. Dated September 15.

10959. "Galvanic batteries." T. J. JONES. Dated September 15.

10978. "Regulating dynamo machines." A. BERNSTEIN. Dated September 16.

11051. "Electric current meters." F. BOREL, E. PACCAUD. Dated September 17.

11056. "Telephonic transmitters." G. L. ANDERS. Dated September 17.

11057. "Telephonic transmitting instruments." G. L. ANDERS. Dated September 17.

11064. "Grapnels for cutting and holding submarine cables." W. C. JOHNSON, S. E. PHILLIPS. Dated September 17.

11094. "Alluminating (*sic*) the dial or part of the dial [of clocks] with an electric light." G. H. JAMES. Dated September 18.

11102. "Establishing electrical communication between lightships, and other floating bodies, and the shore." F. LAKE. Dated September 18.

11117. "Porous pots or cells and partitions or plates for galvanic batteries." G. A. SCHOTH. Dated September 18.

11120. "Telephonic apparatus." S. P. THOMPSON. Dated September 18.

11121. "Apparatus for supporting or carrying and connecting the wires of acoustic telephone circuits." G. L. ANDERS. Dated September 18.

11142. "Dynamo-electric machines." W. A. CARLYLE. Dated September 19.

11153. "Treating wines and liquors with electricity, and apparatus for the purpose of carrying out the same." E. J. FRASER. Dated September 19.

11175. "Arc striking mechanism of electric arc lamps." C. F. COOKE, T. ROBINSON. Dated September 19.

11212. "Railway and Tramway track support and conduit for electric conductors." J. H. GOULD. Dated September 21. (*Complete.*)

11213. "Ships' compasses." A. MITCHELL. Dated September 21.

11224. "Electric baths." M. HUMM. Dated September 22.

11243. "Plates for accumulators or secondary batteries." J. HENRY. Dated September 22.

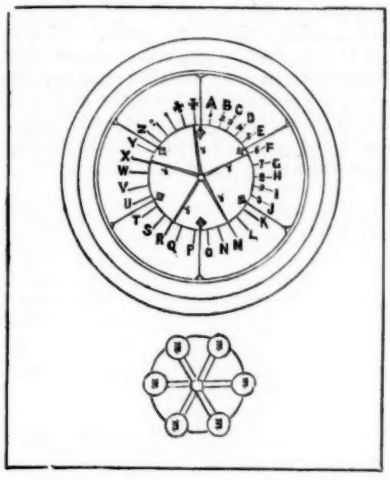
11264. "Telephone." G. L. ANDERS. Dated September 22.

11265. "Appliance for facilitating the transmission and reception of telephonic sounds." H. A. KENT. Dated September 22.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

5201. "Improvements in induction apparatus for transforming electric currents." C. D. ABEL. (Communicated from abroad by C. Zipernowski, M. Dèri, and O. T. Bláthy, all of Budapest.) Dated April 27. 4d. The inventors make the core of the induction coil of a ring of insulated iron wires, in a similar manner to the iron armature of a Gramme ring. This ring is surrounded with copper wires in such a way that the electric current flows through all the convolutions of the primary wrapping in the same direction, and therefore no magnetic poles will be generated in the iron core; one part of the wire convolutions takes up the inducing current, whilst the other part gives off the induced currents.

5212. "Improvements in alphabetical electric telegraphic instruments." R. C. WILLIAMS. Dated April 28. 6d. The dial contains a number of letter spaces equal to the product of multiplication of two numbers in sequence, for example, the number of letter spaces might be 30 (as shown in the accompanying fig.), this number being the product of 5 multiplied by 6, or it might be 42, which is the product of 6 multiplied by 7. The inventor divides the dial with 30 letter spaces into six sections by placing marks upon it at equal distances from each other, and he prefers the form and position of these marks to be as shown in the drawing, but the marks might be placed either under or above the central letter, the first or the final letter of each section. If there were 42 letter spaces the dial would be divided into seven sections, and in other cases the number of sections would correspond with the greater of the two numbers in sequence the product of multiplication of which gives the number of letter spaces upon the dial. The index or hand by which the letters are pointed out has five radii, marked *r* upon the drawing, fig. 1, equidistant from each other, in the case of a dial with 30 letter spaces; and, in other cases, the number of radii would correspond with the lesser of the two numbers in sequence the product of multiplication of which gives the number of letter spaces upon the dial. It will be seen that in whatever position the index may be placed, only two at a time of its radii can be adjacent to sectional marks upon the dial, and these sectional marks contain or form the boundaries of one and the same section; for instance, in the drawing of the dial the section contained between sectional marks adjacent to radii of the index is section A to E. At each step in a "step by step" motion of revolution, though the index only moves at each step a distance equal to a single letter space, first one and then another of the sections of the dial will be pointed out, and all the sections will be pointed out in succession by radii of the index coming successively into juxtaposition to the marks which contain each section. Letters are indicated by the index being caused to advance and then stop for an instant with two of its radii near or adjacent to the sectional marks which contain the



section in which the letter to be indicated is placed, the letter being finally indicated by the index being stopped a second time when it has advanced, so that one of the radii, which before pointed out the section, points to the letter itself. It will be seen that, by the use of this dial and index, any letter could be indicated by a maximum of eleven steps; any section being indicated by, at most, six steps, and only five steps intervening between any of the sectional marks, and the furthest removed of the following five characters.

5219. "An improved non-interfering fire alarm telegraph system, applicable for use as a telephone system." L. H. M'CULLOUGH. Dated April 28. 6d. The result is accomplished partly by means of an arrangement of circuits, and partly by means of an improved central office apparatus.

5657. "Improved means or apparatus for lighting railway and other signal lanterns by electricity." J. E. H. GORDON. Dated May 7. 6d. The inventor arranges that in each lantern there shall be two lamps, which lamps are preferably on different circuits supplied from different dynamos or groups of dynamos, or other sources of electricity. A switch is provided in the cabin from which the signal to be lighted is controlled such that either lamp can be lighted as desired, or both can be extinguished (as in the daytime), but that both cannot be lighted at once. In the event of the lamp which is burning going out, either, for instance, by the breaking of its filament or by the stoppage of its supply of electricity or otherwise, the switch handle can be instantly put over so as to light the other lamp, while if the first lamp is broken a new one can be substituted for it at leisure. In order that the signalman may know if any lamp has gone out, the inventor arranges that in such an event a bell rings in the cabin, and an indicator shows which lantern is in fault. This bell goes on ringing until the switch is put over and the spare lamp lighted.

CORRESPONDENCE.

On Distribution of Electricity by Secondary Generators.

In the *Philosophical Magazine* for September, Dr. J. Hopkinson has drawn attention to a possible source of danger in connection with secondary generators.

This communication was reprinted in your issue of September 12th, and could not fail to have attracted the attention of your numerous readers.

In the International Inventions Exhibition the Edison and Swan United Electric Light Company are exhibiting at their stall in the East Arcade 200 Edison-Swan incandescence lamps, supplied from two of the annular induction transformers of MM. Zipernowski-Deri, constructed by M. Ganz & Co. of Buda Pesth The exciting dynamo which supplies the primary current is in the American Court, at a distance of about 800 feet, and the primary current is conveyed by a No. 10 B.W.G. copper wire to the transformers. Dr. Hopkinson has pointed out that as an induction

coil also acts as a condenser it is possible, if its electrostatic capacity considered as a condenser is sufficient, that a discharge current could be obtained from the secondary circuit sufficient to be dangerous if passed through the human body. As soon as Dr. Hopkinson's communication appeared it occurred to me that this source of danger could be removed by connecting one wire of the secondary circuit to earth, and that in this case even if the secondary generators have electrostatic capacity other than a very small quantity, this device will effectually prevent electrostatic accumulation of electricity in the secondary circuit, although a certain small loss of energy will result from the charging and discharging of the secondary generator by electrostatic induction.

At the exhibition accordingly the experiment was immediately tried by taking a wire from one side of the secondary wire and connecting it to a good earth. This does not interfere in the least with the steadiness of the lighting. I mentioned this safeguard against this possible electrostatic accumulation to Dr. Hopkinson, and I have his permission to state that he considers it a complete insurance against any such danger as that to which he has called attention.

It is satisfactory to find that so simple a means removes a doubt that might otherwise have arisen in the public use of secondary generators in connection with electric lighting.

J. A. Fleming,
Electrician to the Edison and Swan United Electric Light Company, Limited.

57, Holborn Viaduct.

With reference to the very interesting communication of Dr. J. Hopkinson, published in your last issue, I beg to state that some facts relating to the system of distributing electrical energy invented by the engineers Zipernowsky and Déri, of the firm of Ganz and Company, Budapest. In this system the transformers are connected in parallel circuit to the mains, and any one of them is supplied with the whole E.M.F. of the generator. Therefore, such a transformer cannot act as a condenser as long as it is connected to both high tension mains. The switches employed are all double acting, *i.e.*, both conductors are disconnected simultaneously. Only in case of a safety fuse in the primary circuit giving way, and the transformer thus being only connected to one of the mains, will the induction coil act as a condenser and provoke the danger pointed out by Dr. Hopkinson. But we amply provide against the possible risks of such an occurence by the exceedingly low electrostatic capacity of the transformers. Our latest apparatus for ten horse-power, that is capable of transforming a current of 1,500 volt and 5 ampère into one of 60 volt and 118 ampère (the commercial efficiency being fully 95 per cent.) has a capacity of only 0·0018 microfarad, while those shown at the Inventions Exhibition have about one quarter of this. The value of 0·3 microfarad mentioned by Dr. Hopkinson is about the capacity of a secondary generator of Gaulard and Gibbs for two horse-power, this apparatus being, indeed, a rather well designed condenser.

O. T. Blathy.

Budapest, *September 19th*, 1885.

Reis's Telephone.

I do not doubt that "G. R." is quite correct in stating that music is called "die Tonsprache" by German musicians and musical enthusiasts; only, unfortunately, Philipp Reis did not belong to either of these classes, but was a school teacher and a scientific man. I have heard English musicians speak of a certain small-sized fiddle as "the cat." * But that does not prove that when Professor Huxley uses the word "cat" he uses it in the musician's sense.

Whatever Reis meant by his use of the word *Tonsprache* (literally, *tone-speech*), he meant something which included both vowels and consonants, for he said so.

Though I have made myself responsible for the words I have used in translating the expression, I did not do so without having first consulted a distinguished German, a man of science conversant with English and with physics. Nevertheless, as I have said above, I do not dispute the accuracy of "G. R.'s" statement about musical enthusiasts; and I fail to see that it has anything whatever to do with the question as to the intentions of Philipp Reis, who was not one.

Will "G. R." kindly favour me with an English translation of the following sentences?—"*Wie sollte ein einziges Instrument die Gesammtwirkungen aller bei der menschlichen Sprache bethätigten Organe zugleich reproduciren? Dieses war immer die Cardinalfrage.*" (Reis, Jahresbericht des physikalischen Vereins zu Frankfurt am Main, 1860–61, p. 58, lines 5-7.)

Silvanus P. Thompson.

Life of Lamps at the Law Courts.

My reason for adding the decimal in the average of the life of the lamps at the Law Courts was that the quotient would not work out in whole numbers, so I must add a decimal or an x, and I don't like unknown quantities.

I suppose "X.'s" modesty is represented by his *nom de plume*, and that is why he waited for someone else to ask the question he asks.

As "X." remarks, my rule would not apply in the hypothetical cases he quotes. But as the Law Courts installation has been running for a fraction of the 50 years in which he thinks the errors of my computation might be eliminated, and as the longer the installation runs the worse *should* be the results under my method of calculation—I having based that calculation on the last nine months of the period—venture to think that if not exactly theoretically correct, my method is near enough for all practical purposes, "*even to the decimal.*" Again, it must be borne in mind that the installation was found complete with lamps in their various stages of decay at the commencement of the record on which my calculations were based, and was left so at its close.

If "X." happens to be satisfied with this explanation I shall have falsified the saying of the Greeks, and be quite happy even before death.

A. Grundy.

London, *September 22nd*, 1885.

Cooling of Wires in Air and in Vacuum.

In your issue of 19th inst. you publish an abstract of a paper read before the Mathematical and Physical Section of the British Association by Mr. J. T. Bottomley "On the Cooling of Wires in Air and in Vacuum."

I do not intend entering into controversy with the eminent scientists who took part in the discussion but only to put on record a fact, doubtless well known to many electric light men besides myself.

In testing incandescent lamps, one sometimes finds one which presents the double peculiarity of running "dull" and of the glass becoming unusually hot. If the lamp is worked it soon blackens and breaks, and sometimes I have broken the glass, and noticed that the report produced was less than usual. I have always set down such lamps as having a bad vacuum, and imagined that convection and conduction by the enclosed gas molecules accounted for the phenomenon. This idea is supported by the similar behaviour of a lamp which gets cracked slightly while burning. May not a partial vacuum be a better heat conductor (as it is a better electrical conductor) than air at atmospheric pressure?

Henry M. Sayer.

Eastbourne, *September 21st*, 1885.

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* Professor Thompson is in error here, it should be "Kit."—EDS. ELEC. REV